ACCESS, UTILIZATION AND MANAGEMENT OF WATER RESOURCES OF NAIROBI, NGONG AND MATHARE RIVERS OF NAIROBI CATCHMENT BASIN, KENYA

Zachary Arochi Kwena

Access, Utilization and Management of Water Resources of Nairobi, Ngong and Mathare Rivers of Nairobi Catchment Basin Kenya

1999

ACCESS, UTILIZATION AND MANAGEMENT OF WATER RESOURCES OF NAIROBI, NGONG AND MATHARE RIVERS OF NAIROBI CATCHMENT BASIN, KENYA

RESEARCH REPORT SUBMITTED TO FRENCH INSTITUTE OF RESEARCH IN AFRICA (IFRA)

BY

ZACHARY AROCHI KWENA

KENYATTA UNIVERSITY

DEPARTMENT OF GEOGRAPHY

P.O. Box 43844 NBI

tel. 810901 ext. 519

JUNE 1999

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ACKNOWLEDGEMENTS

A number of people helped in various capacities and stages in the preparation of this report. I thank very much French Institute for Research in Africa (IFRA) for funding this research. I appreciate assistance received from Alfred Anangwe and Susan Mbuthia during data collection. I also thank very much Dr. Chris Shisanya, Dr. Zadoc Ogutu, Meleki Khayesi and Isaiah Aduwo for their advice. Lastly, I appreciate moral support from Peter Wafula and all members of Senegal 11

ABSTRACT

This study investigated land use activities along Nairobi, Ngong and Mathare rivers, uses of waters from the rivers and their management. The objectives of the study were:

a) To identify and describe land use activities along the valleys of Nairobi, Ngong and Mathare rivers

b) To assess the effects of land use activities along Nairobi, Ngong and Mathare rivers on the quality of water in their river channels

c) To establish the uses of Nairobi, Ngong and Mathare rivers to the people along their river valleys

d) To examine the role of the people along the river valleys and other stakeholders in the implementation of the conservation programs.

The study used a combination of primary data collected via questionnaire, questionnaire schedules and observation record sheet and secondary data from libraries. The data collected was analysed by use of frequencies, percentages, cross tabulation, chi-square, factor analysis and SWOT analysis. A questionnaire based survey collected information from 96 respondents.

When the 96 respondents were asked whether they were aware of environmental degradation in Nairobi city, 90 (93.7%) respondents answered in the affirmative while 6 (6.3%) in the negative. When asked the aspect of environmental degradation they were aware of, 77 (85.5%) indicated that they were aware of water/river pollution. When the respondents were asked what people used waters of Nairobi rivers for, 51 respondents (56.7%) stated that people used the waters for

irrigation, 46 (51.1%) said people used the waters for domestic washing while 45 (50%) said people used the water for waste disposal. When the respondents were asked what they were doing as individuals to conserve the rivers, 48 (53.3%) stated that they managed domestic wastes which found their way into the rivers thereby causing pollution while 26 (28.9%) admitted that they were doing nothing. The 90 respondents who were aware of environmental degradation in Nairobi were presented with a list of eleven factors that retard conservation efforts of Nairobi rivers and asked to rank them once on a qualitative scale: very important, important, fairly important and least important. Lack of political will had the highest frequency on the very important scale (55 or 61.1%) followed by corruption and lack of law enforcement (53 or 58.9%). Factor analysis performed on the factors showed that there is a pattern of association in the ranking of the factors.

When the five organizations identified to have a stake in the conservation of Nairobi rivers were asked what programmes they had for conservation of Nairobi rivers, they stated that they had no programmes specifically for Nairobi rivers but had for their whole area of operation. The chi-square tests performed revealed that the differences observed were significant. This means the differences were not due to chance but they occur in the real population.

INTRODUCTION

1.1 Background to the Study Problem

Nairobi rivers, particularly Nairobi, Ngong and Mathare have played a key role in the emergence and development of Nairobi as an urban centre. Nairobi was chosen as a suitable stopping place by the railway constructors because of among other things cool clean water known to the Maasai as "enkare nairobi" (Situma, 1992; Ongweno, 1992; Aduwo, 1990). In fact, the settlement of different social groups during the early periods of the city's growth was guided by Nairobi rivers. The more affluent groups, mostly Europeans, were settled to the north and western part of the city where the rivers' waters were clean before being polluted downstream.

Water resources in Nairobi have become a strategic commodity, with supply limited in terms of quality and quantity, and demand increasing due to population growth and economic development. As such, supply of safe drinking water seem to be the main preoccupation of Nairobi City council with minimum success (Situma, 1992). The supply has been loop-sided and skewed towards the urban rich with some parts of Nairobi experiencing frequent 'city droughts. In fact, the poor, who are residents of 'city drought' prone areas pay more for water resources compared to the rich (Smith, 1996; Lamba, 1994).

In the recent past, the quality of water in Nairobi rivers which would have been used to supplement the available water resources has greatly deteriorated as a result of the growth of Nairobi city. Nairobi rivers become increasingly polluted from the point they enter the city (Wandiga, 1996). This shows that urbanization has pronounced effects on them as they pass through the build up areas. These rivers have seemingly been sacrificed to urbanization by transforming them from

natural water course into sewage canal. The pollution of these rivers is expected to intensify as Kenya strives towards industrialization by the year 2020 (Kenya, 1997), especially in the face of a weak regulatory framework. Pollution of these rivers stem mainly from agricultural, domestic and industrial activities (Wandiga, 1996; Ohayo-Mitoka, 1996; Kithiia, 1992; Odipo, 1987).

The evidence of water stress and access problems is apparent in Nairobi. With a population of over 2.5 million coupled with economic development, excess demand for water is created. This necessitates the use of local water resources in Nairobi to complement the supply. However, this is not possible since access to water resources in Nairobi rivers is a big problem to many users. The inaccessibility to these water resources results from low quality and quantity of water reaching downstream users. This often creates conflicts between upstream and downstream users (UNEP, 1997; UNEP *et al,* 1989). There exists cases where individuals abstract and diverge courses of Nairobi rivers to satisfy their own needs without due regard to the downstream users.

Rivers and their bank areas fulfill a great number of socio-economic functions particularly in urban areas. As such, Nairobi rivers are used for different purposes although these uses are limited to the quality of water in the rivers. Some of these uses result to pollution of the water resources in the rivers affected. The utilization of these rivers change downstream especially after crossing the city centre. The common uses of these rivers are:

- Domestic (drinking, cooking, bathing, washing)
- Construction (mixing sand, concrete and cement)
- Irrigation (watering horticultural crops, flowers, houseplants, tree seedlings)
- Washing vehicles (especially in Jua Kali garages)

- Sewerage system (especially in slum areas)
- Recreation (sporting and swimming activities)
- Social functions (circumcission, baptism)

Developing sound water resource management programs is crucial for Nairobi's poverty reduction, economic growth and maintenance of natural systems. Water availability for household consumption and for productive use is closely associated with poverty reduction. Thus it is urgent to secure efficient, equitable and sustainable use of Nairobi's water resources for present and future generations.

All stakeholders have a role to play in the management of Nairobi rivers. The government provides environmental policy and legislation to guide in the utilization of rivers and their water resources. Experience indicates that no public environmental conservation program succeeds without practical government support in form of legislation, policy, personnel, finance and institutions (Kipkore, 1996). Apart from the central government there exists governmental and non-governmental organizations to spearhead the management of water resources (NEAP, 1994). In addition individuals along the river valleys have a duty to conserve these rivers. Despite the existence of this framework, the rivers continue to face environmental problems such as pollution and erosion.

Intricate network of land use activities along Nairobi rivers have great effect on the accessibility, utilization and management of water resources in these rivers. The observed land use activities along these rivers include: farming, residential, commercial, industrial and recreational. All these land use activities are randomly spread with no clear pattern. Given the intensity of activities

engulfing Nairobi rivers, there is need to understand the relationship that exists between land use activities, water utilization and management of these rivers.

1.2 Statement of the Research Problem

Many land use activities such as agricultural, industrial and residential exist along the valleys of Nairobi, Ngong and Mathare rivers which are not compatible with the carrying capacity and potential sustainability of the land (Howard, 1998; Lamba, 1994). These land uses lead to degradation of the river valleys through soil erosion and waste dumping. These lead to deterioration of water quality in these rivers, thereby affecting their utilization by people in the river valleys.

Previous studies such as Njuguna (1978), Odipo (1987), Kithiia (1992), Ohayo-Mitoka (1996), Wandiga (1996), Otieno (1998) and Ndaruga (1998) have concentrated on the measurement of pollution levels and tracing the sources of pollution to Nairobi rivers. Building on previous research work, there is need to investigate the status of use of these rivers and the resultant effects. *The study examined land use activities along Nairobi, Ngong and Mathare river valleys, uses of the rivers and their conservation.*

1.3 Research Questions

This study addressed the following research questions:

a) What land use exists along the valleys of Nairobi, Ngong and Mathare rivers? How do these land use activities affect the quality of water in the river channels?

b) How do people along the river valleys use the rivers? What are the conceived effects of the rivers to the people along them?

c) What conservation efforts and programs are employed to protect the river valleys and their waters? How effective is the implementation of these conservation efforts and programs?

1.4 Research Objective

This study sought to achieve the following research objectives:

i) To identify and describe land use activities along the river valleys of Nairobi, Ngong and Mathare.

ii) To assess the effects of land use activities along Nairobi, Ngong and Mathare rivers on quality of water in the river channels.

iii) To establish the uses of Nairobi, Ngong and Mathare rivers and their waters to the people along the river valleys.

iv) To examine the role of the people along the river valleys and other stakeholders in the implementation of the conservation programs and strategies.

1.5 Justification for the Study

Nairobi rivers are experiencing environmental problems such as pollution and erosion resulting from socio-economic activities in their river valleys (Howard, 1998; Wandiga, 1996; Lamba, 1994). There is therefore need to harmonize land use activities taking into consideration the potential carrying capacity of the land. This can be done if knowledge of the dynamics of land use activities and their effect on water quality is known. This study aimed at providing the basic data required for the harmonious merge of the two.

Water resources are very important for agricultural, domestic, industrial and ecological uses (Odira, 1996; Abwao, 1993; Kithiia, 1992). It is especially critical in the role it plays in the welfare of urban residents and has widespread linkages to many aspects of their lives. These uses require good quality water in the rivers. It is not clear what the current uses of Nairobi rivers are given their poor quality. This study provided data to shed light on the current uses of the rivers downstream.

As the population and socio-economic activities in Nairobi city intensify, especially in response to the governments strategy for industrialization by the year 2020 (Kenya, 1997), the pollution of water resources in Nairobi rivers is bound to increase given the existing weak regulatory framwork. This limitation calls for the urgent need for data base on the current efforts to address the effects of industrialization on Nairobi rivers with a view of coming up with recommendations that will help enhance conservation efforts.

Rivers passing through Nairobi city feed Athi River which passes through areas with insufficient rainfall (Ongweny, 1993; Howard 1998). Athi River is used for irrigation, livestock watering and for domestic purposes, hence the need for clean water (Ogola, 1998). Heavy silt load at Baricho water supply and port of Malindi interfere with their operations. Clean silt-free water can only be available if the catchment is well protected. This study intended to document conservation activities carried out by people along Nairobi rivers which form the upper catchment of Athi River.

1.6 Study Area

1.6.1. Position and Size

Nairobi city extends between 36°4' and 37°10' east and 1°9' and 1°28' south. This covers as total area of 696km^2.

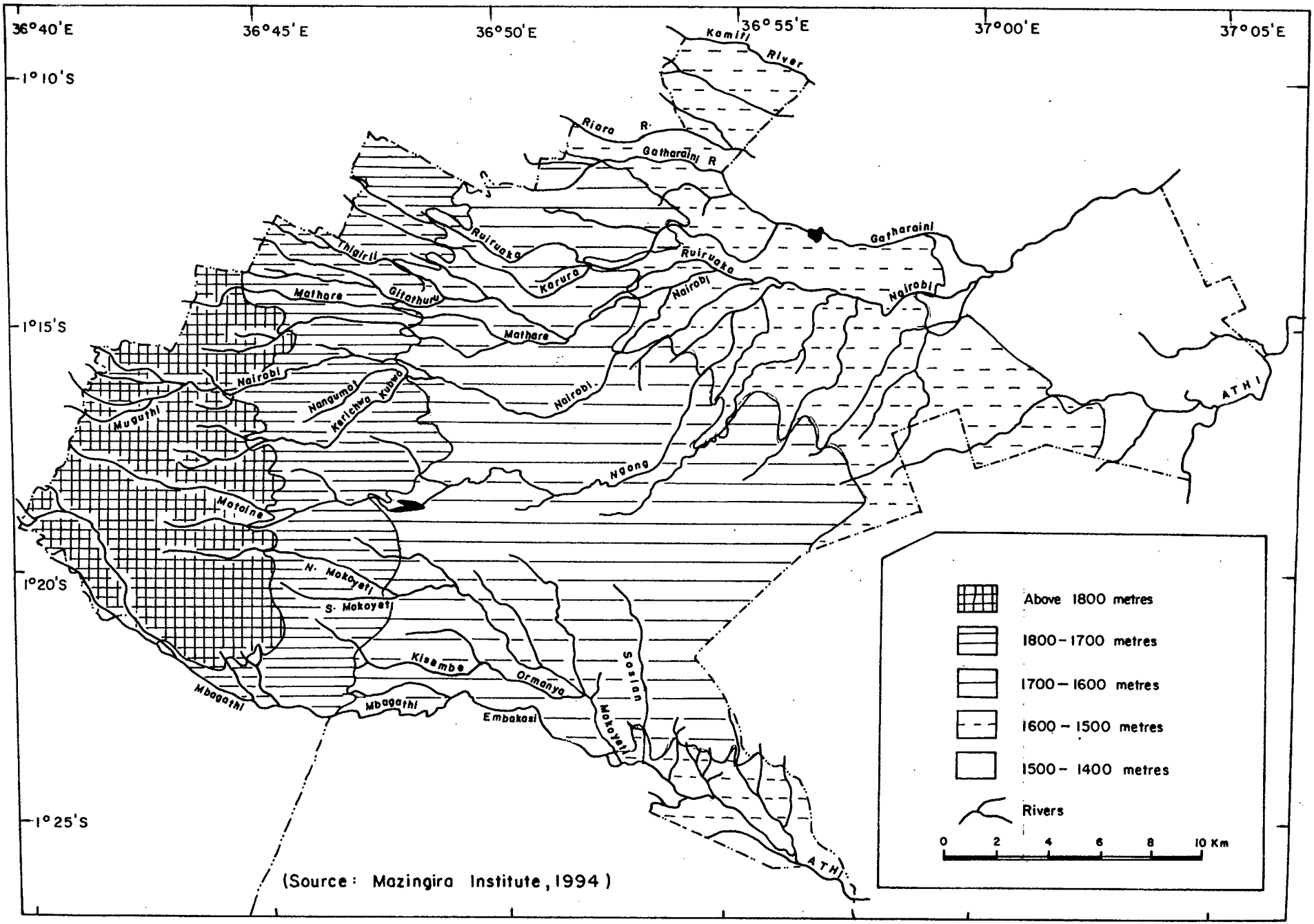
1.6.2. Topography and drainage

Nairobi city is divided into two physiographic units or land forms. The western and the northern parts are generally high rising to 1905 and 1975m above sea level forming part of Kikuyu plateau. Eastern and southern parts are generally lower and flat about 1600m above sea level forming Athi Plains (Fig. 1.1).

Nairobi city consists of numerous tributaries of the Athi River. The rivers originate from Kikuyu highlands and Ngong' hills and flow north-west to south-east direction. These rivers traverse the city passing through areas of different socio-economic activities and population densities. Nairobi city has three major rivers whose characteristics are typical of all rivers that traverse the city or any other major town in Kenya. These rivers are Ngong', Nairobi and Mathare.

Nairobi River originates from Kikuyu escarpment. It then flows through Central Business District (CBD), Eastland residential estates to join Athi River. Ngong' River originates from Ngong' Hills, flows through Ngong' road forest, thickly populated Kibera slum before entering Nairobi dam. After Nairobi dam, it enters industrial belt before again flowing through slums (Mukuru) to join Nairobi River. Mathare River on the other hand originates from Kikuyu escarpment and flows through coffee plantations in Kiambu, then Karura forest. It then flows through Muthaiga high class residential

Fig. 1.1 Drainage and Topography of Nairobi



estate before entering Mathare valley slums, Kariobangi low class estate and Korogocho slums. It then joins Nairobi River.

1.6.3. Geology and Soils

Nairobi city's geology consists of volcanic rocks in the higher parts while the lower parts have dark-grey phonolites. The western part of the city is covered by tuff. Crystalline rocks of Pre-Cambrian age occur as outcrops in Kitengela valley. Poorly drained impermeable soils (vertisols) occur in southern and eastern parts while western and northern parts have fertile volcanic soils (podsols and andesols). Swamp grey soils, alluvium and clay soils occur along river valleys. Sediment and tuff weathered clay soils form suitable raw material for brick and tile making factories.

1.6.4. Climate and Vegetation

Nairobi has two rainy seasons, short and long rains which occur in October-December and March-May, respectively. The mean annual rainfall is about 900mm and decrease from Kikuyu escarpment to the Athi Plains. Temperature conditions are characterized by a small annual range and a large diurnal range due to high temperatures during the day and low temperatures during the night. The mean annual temperature is 17°c and the mean daily maximum and minimum are 23°c and 12°c, respectively.

Nairobi had two distinct natural vegetation. The lower eastern areas were covered by grasslands with scattered acacia trees. This vegetation still occurs around Jomo Kenyatta International Airport (JKIA) and Nairobi National Park. The higher areas to the west and north-west were forested with

hardwood trees. There are still parches of this vegetation in areas such as Karura Forest, Ngong Road Forest, City Park and in the Nairobi Arboretum.

1.6.5. Population and Land Use

Nairobi's population is estimated at 2.5 millions with annual growth rate of 4% (Adebayo, 1992). The average density of Nairobi is 2,600 persons per square kilometre. However, densities vary widely within the city. High income areas have average densities of as low as 2,100 persons per square kilometre while low income areas have average densities as high as 55,000 persons per square kilometre (Lamba, 1994).

Different land uses compete for space in Nairobi. This has resulted to the intensification of some at the expense of others. Most of these land uses ignore environmental issues in the city, a factor that has led to degradation of the city environment. Basically, land uses in the city include residential, industrial, commercial, institutional, recreational and agricultural. These land uses are distributed all over the city.

1.7. Summary

In the foregoing introductory chapter, background to the study problem has been outlined in which the need to use the water resources judiciously has been emphasized. Besides, the statement of the problem, research questions, objectives, and hypotheses have been presented. Finally the chapter has outlined the basic characteristics of the study area.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.0 Introduction

This chapter reviewed existing literature in the light of the problem under investigation. The purpose of the review was to contextualize the research theme. The review was presented thematically in order to identify gaps that this study aspires to fill. Finally, the chapter outlined conceptual framework used to guide the study.

2.1 Literature Review

2.1.1 Degradation of River Systems

Properties of water in rivers reflect the state of a drainage basin (Gulubev, 1993; Ells and House, 1994). When the processes in the basin are natural, the river transports natural substances and the water remains clear. As soon as human activities such as agriculture, industry and commerce intensify due to urbanization, physical, chemical and biological properties of water change. However, the activities along the river valleys have the greatest impact on the water quality due to their proximity to the river channels.

Nairobi has a high concentration of socio-economic activities which affect the quality of water in its river systems. Lamba (1994) and Karembu (1990) point out the dangerous use of agrochemicals by small-scale farmers leading to pollution of Nairobi rivers. This happens despite the multiple uses of these rivers downstream.

Lamba (1994) and Situma (1992) observe that soil erosion is rampant along Nairobi rivers and road reserves. They attribute this to construction and agricultural activities taking place throughout the city. Erosion and sedimentation subsequently pollute water resources in rivers in addition to causing flooding through blocked drainage channels as was witnessed in early 1998. Lamba's study identifies river valleys, road reserves and quarries as the most vulnerable sites for erosion if not properly conserved.

Ohayo-mitoko (19969, Wandiga (1996), Thenya (1994) and Odira (1991) demonstrate that rivers passing through urban centres such as Thika, Ruiru, Nairobi and Ngong are in danger of receiving wastes beyond their assimilative capacity. This undermines their natural self-purification capacity, making them heavily polluted. This study brings to light the purposes the polluted Nairobi rivers serve to the urban poor.

Breen *et al* (1994), Odundo (1994), Abwao (1993) and Krhoda (1992) demonstrate that storm run-off within urban centre is of poor physico-chemical and biological quality which ends up in urban river systems with consequent ecological disruptions. Abwao (1993) and Krhoda (1992) attribute the poor quality of storm run-off to poor general sanitary situation of Nairobi city. As a result, kerb inlets, channels and natural rivers need to be kept clean from garbage and siltation to enhance water quality.

Wandiga (1996), Ohayo-Mitoka (1996), Kithiia (1992) and Odipo (1987) identified industrial, domestic and agricultural activities as the cause of water quality deterioration in Nairobi rivers.

Accordingly, water in most of Nairobi rivers is highly polluted with major pollutants being heavy metals, pesticides and suspended solids.

Kinyua and Pacini (1991) and Ndaruga (1998) attribute the absence of biota in some parts of Nairobi and Gatharaini rivers to pollution. Their studies reveal that fauna and flora had disappeared completely from sections of these rivers where pollution level was high. These poses a threat unless proper conservation approach is adopted, especially involving collaborative effort.

An outline of relevant studies given above indicates that there is need for further research to examine the prevailing land uses along Nairobi rivers and their effects on water quality. Hence the need for the present study to address this gap in literature.

2.1.2 Conservation of River Systems

Water resources, water hazards, water pollution and wetland habitats are close to the heart of the modern natural resource management dilemma in many regions of the world (Newson, 1992). This necessitates that rivers be managed in the best way possible for the purpose of reaping the benefits associated with such rivers.

Effective conservation of river systems depend on the approach employed and the level of involvement of stakeholders. Moigne *et al* (1994) and Koudstaal *at al* (1992) stress the importance of inclusion of stakeholders from the very beginning of program design. This inclusion helps to gather information, clarify goals of policy and create a sense of commitment that can help implement an effective policy and intervention program.

World Bank (1996) observes that point and non-point sources of pollution in a river system can be reduced using policies that combine regulations, economic instruments, public education and enforcement measures. In addition, there is need for support at the highest levels, this has to be in a form of politically stable climate, as well as a sound institutional and legal framework, a good base of information and knowledge and the involvement of the affected people.

Kipkore (1996) reports that problems related to soil and water conservation in rivers are being addressed by many government departments and non-governmental organizations. Although this multiple approach has potential of yielding better results, if not well coordinated results to overlap and duplication of efforts leading to confusion of the players.

Kenya (1991), Okoth-Ogendo (1991) Ohayo-Mitoko and NCC (1997) observe that Kenya's environmental conservation legislation is adequate to deal with pollution and conservation prblems. However, its enforcement is poor partly due to being compartmentalized in various Acts and Ministries. This state of affairs calls for coordinated monitoring and conservation of water resources.

Ariel (1995) argues that stakeholder participation, legal and regulatory reforms and an emphasis on environmental protection and restoration are all integral for a comprehensive framework improving water resources management. The various aspects of legal and institutional framework have to complement and reinforce each other in their management of water resources.

According to Frederiksen (1992), pollution of surface water bodies by urban/industrial effluents, domestic wastes and agricultural wastes can easily be cleaned up if actions to prevent pollution is taken. This can only happen if various land uses are harmonized with environmental concerns. Managing water in isolation of land use impacts is an unrealistic venture. All land use and water use and their regulatory functions should be integrated in management operations.

Efficient water management requires that water quality and quantity be dealt with consecutively. The options for using a given water source depends directly on its quality and the maintenance of that quality. Changes in land use generate significant changes in water quality and therefore land use along the rivers ought to be in harmony with water resources in the rivers.

World Bank (1993) contend that integrating land use policies and practices with water management in river basins is important for formulating policies to manage water resources in rivers. The proper management of upstream watersheds if often critical for sustaining water quality and aquatic ecosystems. Land use policy together with incentives should aim at making land users bear the costs that their land management practices impose on others and encourage cost effective management practices that control surface and ground water pollution and foster soil conservation.

Successful integrated and sustainable approaches to the management of river basin corridor environments in urban catchments require a combination of organizational and institutional co-operation and planning in addition to implementing sound and sustainable engineering and ecological principles (Ells and House, 1994). Similarly, Nairobi river systems require such coordination in the institutional networking to address conservation problems in the river

ecosystem. Potential tenets and any other limitations for collaborative efforts have not been explored. This study was geared towards addressing this gap in literature.

NEAP (1994) and Lamba (1994) argue that first growing population in Nairobi, coupled with absence of a comprehensive land use policy have increased demand for expansion of urban agricultural and industrial activities with resultant vast amounts of waste dumped into the river systems. These two forces have witnessed pollution of water resources in Nairobi rivers to the extent of the latter being considered as flowing sewage.

World Bank (1993) recognizes that water management is fragmented and stresses for a comprehensive framework for formulating policies and public decisions that takes into account the interdependencies that characterize water resources. Water use in all its forms impinges on natural ecosystems and health of people. This in turn stresses the importance of assessing and mitigating environmental consequences of public investment (especially along the rivers) and of establishing effective regulatory policies.

The Dublin international conference on water and environment of 1992 outlined four guiding principles in water resources management. Among them were:

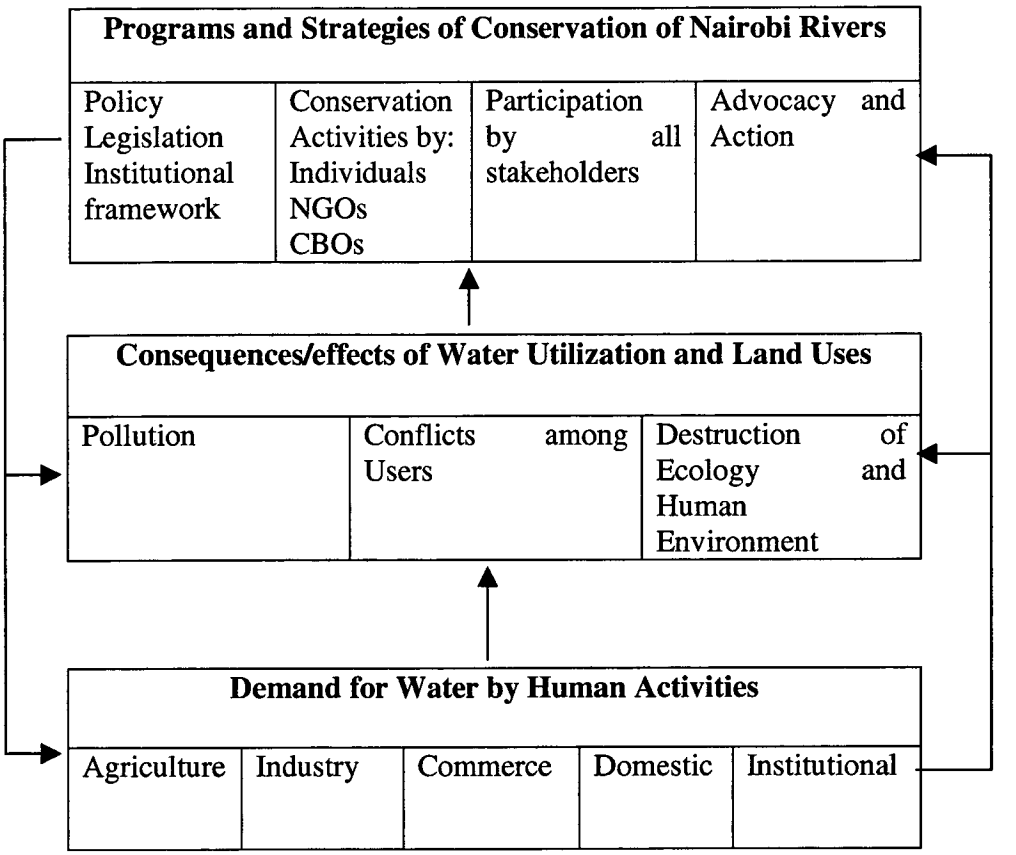
- The need for holistic (integrated) approach in effective management of water resources linking social and economic development with protection of natural ecosystems including land and water linkages across catchment/basin areas; and
- The need for water development and management to be based on a participatory approach involving users, planners and policy makers at all levels.

Musgrave (1978) and Krishnamurthy (1984) argue that river systems should be considered as integral ecosystems, stressing the need to integrate the management of various factors in the upper regions which have an effect on the resources and activities in the lower part of the basin. Musgrave (1978) reports that it was not until Britain passed an Act that integrated interests of water users in the river systems that their conservation efforts were realized. The object of the 1973 British water Act was to achieve integrated management of the hydrological cycle throughout the river system. This Act saw River Thames, which passes through London city clean up to become a beautiful and magnificent river. The possibility of whether or not the same approach can be used in the management of Nairobi Rivers was explored in this study.

2.2 Conceptual Framework

Water is needed in all aspects of human life, moreso in urban areas where it is put into various uses. As such, adequate supplies of good quality water to meet raising demands by human activities is necessary. Human activities which use water include: agriculture, industry, commerce, household and institutions. Water to service these activities can either be from 'imported' sources through pipes and via taps or from natural water bodies. For natural water bodies such as rivers to be used, they must contain adequate good quality water. Excessive utilization of water and unsustainable land uses lead to problems such as pollution of water resources, conflicts among users and general disruption of ecological and human environments (2.1).

Fig. 2.1: A Framework for Assessment of water utilization and management



Pollution in these rivers is caused by agro-chemicals, industrial waste water and domestic solid wastes that find their way into the rivers through storm run-off and leaching. Conflicts among water users come in two categories, those related to quality and those associated with quantity. However, quality conflicts are more common with Nairobi rivers where some individuals use large volumes of water and pollute the remainder denying the downstream users water of good quality. Similarly, disruption of ecological and human environments have negative effects on biodiversity, aesthetics and human health. All these negative effects on water and its users necessitate a comprehensive management strategy that works towards their solution.

Comprehensive management to check the effects of land use and water utilization will require that conservation strategies and programs are formulated by stakeholders. The government provides policy and legal framework to guide in the conservation exercise. However, apart from providing them, it must make sure that they are implemented and enforced. Similarly, governmental and non-governmental organizations organize various activities aimed at conserving the rivers. These activities by various institutions should be done in the light of activities of other governmental and non-governmental organizations to avoid duplication of efforts as it happens when they carry out their activities in 'dark rooms'. To cement the conservation exercise, participation by all stakeholders is greatly encouraged to enhance the implementation and subsequent achievement of conservation goals. In addition, advocacy and action by researchers play a big role in the provision of the information required for implementation of conservation strategies and programs.

2.3 Summary

This chapter has highlighted existing literature in regard to the problem under investigation. Themes handled in this section are degradation of water systems and conservation of the same. The need to involve all stakeholders in the conservation process is spelt out in addition to harmonizing various land use activities with the potential carrying capacity of the land. The costs of polluting water resources are highlighted and the need for judicious use of the resources stressed. Given that the urban poor use water from natural sources, it is imperative for water in the river to be kept free from contamination. Finally, the conceptual framework that was used to assess land use, water utilization and management is explained.

CHAPTER THREE

METHODOLOGY AND SCOPE OF THE STUDY

3.0. Introduction:

This chapter presents methodologies used in this study. This study involved field-work where questionnaire and observation record sheet were used. In addition, methods of data analysis are outlined. Finally, the scope of the study is spelt out.

3.1. Sampling Design

The respondents for this study were drawn from the estates through which Nairobi, Ngong' and Mathare rivers flow within Nairobi city boundaries. Efforts were made to sample people whose houses or other economic activities are found close to the rivers. The stretch of the rivers was divided into three sections, i.e. the section of the rivers before crossing the city centre (Upper Section). The section of the rivers within the city centre (Middle section) and lastly the section of the rivers after the city centre (Lower section). The respondents were drawn from all the three sections.

A sample size of 96 respondents was interviewed at least 30 from the three river valleys (Mathare, Nairobi and Ngong). Purposive random sampling was used to select the respondents. In addition to individual respondents, five institutions that have a state in conservation of Nairobi rivers were interviewed to reveal their programmes and/or activities in the conservation of the rivers. These institutions were Tana and Athi Rivers

Development Authority (TARDA), Permanent Presidential Commission on Soil Conservation and Afforestation (PPCSCA), Nairobi City Council (NCC), Water Apportionment Board (WAB) and Provincial Administration - District Environmental Officer (DEO).

3.2. Data Collection

3.2.1. Primary Data

This study was mainly based on primary data collected during field-work in months of February, March and April, 1999.

3.2.1.0. Methods of Primary Data Collection

3.2.1.1. Questionnaire

A questionnaire was administered to respondents who did not have time to be interviewed straight away. They were then collected after the respondent had filled at his/her own convenient time. This research instrument was used in interviewing respondents on matters relating to the problem under investigation. Before the final version of the questionnaire was administered, a pilot survey was carried out to pretest the questionnaire and ensure that the items therein were clear and reliable.

The researcher had earlier on carried out a reconnaissance tour to fully acquaint himself with the study area and map out various land uses along the rivers. The questionnaire was designed to capture information on awareness of environmental degradation in the city of

Nairobi. Uses of the waters of Nairobi rivers, and conservation efforts by various stakeholders.

3.2.1.2. Questionnaire Schedule

This method was used alongside the questionnaire and used particularly where the respondent had time to respond to the questions on the spot. This method was also used to elicit information from officials of the five institutions.

3.2.1.3. Observation Record Sheet

Apart from the questionnaire and Questionnaire schedule, observation record sheet was used to record information on degraded sites/resources, their location along the rivers, type of conservation if any and the organization and individual(s) concerned with conservation activity at the site.

3.2.2. Secondary Data

This study also made use of secondary data. The data collected was on pollution levels of the rivers, sources of pollution and conservation efforts by different stakeholders. To get these data, Kenyatta University and University of Nairobi libraries were visited. Other libraries visited were UNEP, World Bank, Ministries of Water Resources, Natural Resources and Environmental Conservation .

3.2.3. Research Assistants

Data collection was done by the researcher and two research assistants. The research assistants were selected on the basis of their ability to apply instructions, communicate with people and accurately record responses on the questionnaire.

3.3. Data Processing and Analysis

Data assembled from questionnaire, questionnaire schedule and observation record sheet was subjected to editing and coding processes. The data was then analyzed. The analyzed data provided answers to research questions and formed a basis for conclusions made on the objectives of this study. The raw data from questionnaire was subjected first to computation of simple statistics such as totals, percentages, tabulations, frequencies and averages (mean, median and mode). The processed data was then presented in form of tables. Chi-square was used to test differences between groups of responses given. Factor analysis was performed to detect and identify groups that had high association/correlation. Finally, SWOT analysis was performed on data obtained from the study to assess the conservation efforts of Nairobi rivers and identify critical areas for strategic management.

3.3.1. Chi-square:

Chi-square (X^2) is a statistical test used to evaluate whether observed frequencies differ significantly from those which would be expected under certain theoretical assumptions. Its formula is:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where:

O = the observed frequencies

E = the expected frequencies

Degrees of freedom (df) is obtained by the formula (Hammond and McCullagh, 1974).

df = n-1

where df = degrees of freedom

n = number of observed units

The X^2 test is a measure of the aggregate difference between the observed frequencies and those expected under the null hypothesis (HO) so that the greater its values, the less likely it is that the null hypothesis is true. The X^2 test enables a decision to be made on whether or not a significant difference exists between the observed number of cases falling into each category and the expected number of cases.

3.3.2. Factor Analysis

Factor analysis is a technique of data reduction just as principal component analysis (Johnston, 1980). Factor analysis in this study was used to classify variables into groups of related factors and to determine if the groups of factors identified are statistically significant. Factor analysis was preferred to principal component analysis (PCA) because the former identifies common patterns among variables.

Unlike principal component analysis, factor analysis distinguishes between common and unique variance. Common variance is the proportion of the total variance in the dependent variables accounted for by combined variances of the independent variables. By focusing on common variance, factor analysis is able to identify common patterns in a set of variables. Therefore, the main advantage of factor analysis over principal component analysis is that, the later clearly identifies interrelationships among variables based on common variance only (Johnston, 1980).

Statistical Package for Social Sciences (SPSS) was used for factor analysis. In factor analysis, correlation matrix is derived from the data. This matrix gives sets of interrelated variables. After this, varimax rotation is performed to search for simple and interpretable factors. The rotation ensures that each factor is orthogonal (uncorrelated) to each other. Eigen values are used to make decision on cut-off point to select significant factors. After the factors are isolated, suitable names to describe the factors are sought.

3.3.3. SWOT Analysis

SWOT is an acronym for strengths, weaknesses, opportunities and threats of an endeavour. It is an analytical took used for strategic management of premises. SWOT analysis was performed to identify key critical areas necessary for strategic management. SWOT analysis provides the decision and policy makers with information that form the basis for making decisions and actions aimed at achieving set objectives. It enables an endeavour to be prepared to exploit opportunities while combating threats. Results from SWOT analysis

may offer pointers towards change in objectives, policies, strategies or institutional arrangements.

SWOT analysis begins with identifying and making a list of strengths, weaknesses, opportunities and threats of an endeavour (Dyson, 1990). The four factors interact suggesting various strategies for possible adoption. Strengths and weaknesses are carefully evaluated to come up with important strengths and fatal weaknesses that determine the performance of an institution. SWOT analysis finally comes up with critical areas and strategies necessary for strategic management.

3.4. Scope of the Study

This study covered three rivers within Nairobi City boundary, namely Nairobi, Ngong' and Mathare, which flow through areas with different socio-economic activities. Since these rivers are typical of all other rivers passing through the city, their choice for this study provided overall picture of the status of use and challenges facing rivers in Nairobi. People in estates through which the rivers pass and whose activities are found along the rivers were selected for interview. This is because they have direct effect on the rivers.

The study area stretched from the point the rivers enter to the point they leave the city boundaries. The study concentrated on identifying the various land uses along the rivers

and their effect on water quality in river channels. It also established the uses of the rivers and their waters in addition to examining the conservation of the rivers by a wide range of stakeholders. This study interviewed 96 respondents along the three rivers.

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSIONS

4.0. Introduction

This chapter presents results of a survey on land use along Nairobi, Ngong and Mathare rivers and those from a questionnaire survey of 96 respondents in the city of Nairobi on the uses of Nairobi rivers and their management. Research questions addressed in this chapter are:

- What land use exists along the valleys of Nairobi, Ngong and Mathare rivers? How do these land use activities affect the quality of water in the river channels?
- How do people along the river valleys use the rivers and their waters? What are the conceived effects of the rivers to the people along them?
- What conservation efforts and programs are employed to protect the river valleys and their waters? How effective is the implementation of these conservation efforts and programs?

Six hypotheses are verified in this chapter:

- HO_1: There is no significant difference in the use of natural resources in Nairobi by respondents
- HO_2: There is no significant difference between various aspects of environmental degradation known by respondents
- HO_3: There is no significant difference in the uses of waters of Nairobi rivers reported by respondents

- HO_4: There is no significant difference in the rating of effectiveness of stakeholders supposed to conserve Nairobi rivers
- HO_5: There is no significant difference in the conservation activities of Nairobi rivers by respondents
- HO_6: There is no discernible pattern in the rating of factors that retard conservation efforts of Nairobi rivers

4.1 Socio-economic Characteristics of Respondents

This study sought views from respondents with a wide range of socio-economic characteristics. Among the 96 respondents sampled, 71 (74%) were men and 25 (26%) were women. The age of respondents were classified into four age brackets. The dominant age bracket was between 18 and 30 years that had 67 (69.8%) respondents. The other age brackets were: between 31 and 50 years that had 18 (18.7%) respondents, below 18 years that had 6 (6.3%) and over 50 years that had 5 (5.2%) respondents.

The respondents for this study came from various occupational sectors the dominant being *Jua Kali* (Table 4.1). At least over 65% of the respondents had attained a secondary level of education. Fifty four (56.3%) respondents had secondary level of education, 26 (27.1%) had primary level of education, 12 (12.5%) had post-secondary level of education, 3 (3.1%) had no formal education while one respondent did not respond to the question.

Table 4.1: Occupational Sectors of the Respondents

Sector	Frequency	Percent
Agriculture	13	13.5
Commerce	18	18.8
Industry	6	6.3
Jua Kali	26	27.1
Tourism	1	1
Transport	6	6.3
Education	8	8.3
Others	18	18.7

4.2. Land Use Along Nairobi, Ngong' and Mathare rivers

Land is considered the most valuable resource in urban centres and therefore most sought asset. The demands on available land for various uses are many and often create tremendous pressures and conflicts. Sustainable land use planning becomes crucial as it enables available land to be used reasonably. Although there is dire need for a comprehensive land use policy in Kenya to guide development in Nairobi City and other big towns, it is unfortunate the policy is notably absent (NEAP, 1994).

Historical factors guided by greed and marginalization of the poor who form about 70% of the urban population (Syagga and Kiamba, 1992) continue to influence land use planning in Nairobi (Lamba, 1994). Free and properly coordinated land use planning deal with distribution patterns that best accommodate the various types of development such as residential, industrial, transport and agricultural envisaged in the process of urbanization. Much of Nairobi development is dominated by economic factors that give little consideration to environmental factors and severely limit the access of the poor to the land. The poor have responded to this by illegally occupying fragile lands such as river valleys,

flood plains, quarries and road reserves. As the poor exploits these natural resources to improve the quality of their lives, this consequently lead to degradation of the environment. This scenario has led to development and expansion of poverty areas that are characterized by heavy exploitation of the environment beyond its natural replenishment rate.

In view of this enormous thirst for land, urbanization in Nairobi is characterized by *ad hoc* land use planning with little consideration for environmental impact or physical constraints. The City of Nairobi has grown at the rate of 122% in the last ten years (Nyambok, 1992). This fast growth has increased demand for land for expansion of urban agriculture and industrial activities. Some of these activities, as a result are established along Nairobi, Ngong' and Mathare rivers either by the rich individuals who grab such public lands or by the urban poor who have no alternative but to squat on such land. However, some land use activities are genuine although they have negative effect on the rivers. This has led to vast amounts of waste being generated and dumped into the environment untreated or improperly treated due to poorly operated treatment works.

The unplanned development of small-scale enterprises (*jua kali*) has increased discharge of pollutants including petroleum wastes into rivers and other water bodies. Land use that categories all the three rivers, that is, Nairobi, Ngong' and Mathare is cultivation and residential. Intensive cultivation of horticultural crops, nappier grass, bananas and arrow-roots occur in the upper sections of the rivers. Cultivation land use result into leachates from agro-chemicals, soil erosion and crop residues, which cause pollution in receiving Nairobi rivers (Njuguna, 1978; Odipo, 1987; Kithiia, 1992; Ohayo-Mitoko, 1996 and Wandiga,

Plate 1 : Agricultural land use along Mathare River

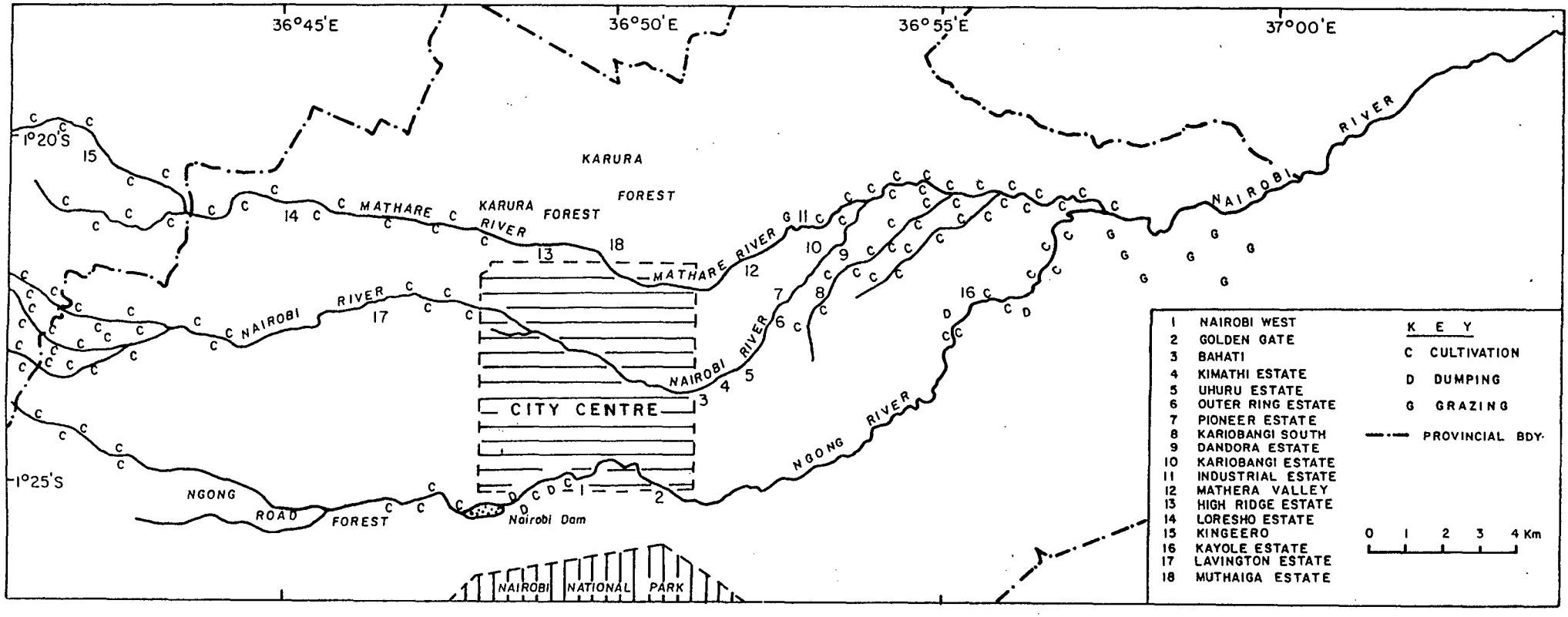
1996). Consequently, users of the rivers get concerned about the quality of water when its physical, chemical and/or biological characteristics deteriorate and become harmful to man, his domestic needs or to a balanced functioning of aquatic ecosystem (Ambasht, 1990).

Residential land use along the rivers has severe negative impact on water quality. Most residential estates found along the rivers are squatter and unauthorized settlements with no sanitary infrastructure (Odundo, 1994). For instance the residents of Ngara, Mathare, Korogocho, Kibera, Mukuru, Dandora and Eastleigh slums areas use the river as their toilets and dump for all types of wastes. Ngong River, which pass through the industrial area carries with it human and industrial waste from the Kibera, Kayaba and Mukuru slums.

Nairobi River originates from Ondiri Swamp and flows through Dagoretti Market. The land uses along the river are slaughter houses and settlements around the market and cultivation. The river then flows through Kawangware and Kangemi low class settlements before entering Kileleshwa high class residential estate. The river has no leave way as it flows through Kawangware and Kangemi estates. Buildings are constructed very close to the river. The leave way of the river as it flows through Kileleshwa estate is used for cultivation of vegetables, sugar cane, nappier grass, arrow roots and bananas (Fig. 4.1).

As the river passes through City Centre, commercial buildings, *Jua Kali* garages, and artisan sheds are constructed very close to the river, directing all their wastes into it. As the river flows past Gikomba Market, in fact, pillars supporting the traders' stalls are erected inside the river. Here traders throw all the vegetable waste into the river and use the area

Fig. 4.1 Land use along Nairobi Ngong and Mathare Rivers



around the river to relieve themselves as there are no toilets in the market. The river then flows through residential estates in Eastlands. At Dandora estate the river flows close to Dandora dumping site thereby receiving more pollutants. Thereafter the river flows through ranches and grazing lands up to where it joins Athi River.

Ngong River flows from Ngong' hills, passing through Ngong' road forest. Before entering Kibera slums and later Nairobi Dam, the main land use along the river is cultivation. The land use then changes to settlement as the river flows through Kibera slums, Nairobi West, South C and South B. After Mombasa road bridge, land use on one side of the river is industrial while on the other is settlement with some cultivation on the leave way. The river then passes through Mukuru slum, grazing land and Kayole estates. After Kayole estate, the river flows through grazing land mixed with some cultivation before joining Nairobi River past Njiru. At Njiru there is some quarrying activities close to the river.

Mathare River originates from Kikuyu escarpment. It then flows through coffee farms mixed with horticultural cultivation in the river valley. There is also livestock rearing with zero-grazing units. The cultivation land use along the river use a lot of agro-chemicals such as herbicides, pesticides, fertilizers and ascaricides. These chemicals are washed to the river during rainy seasons. Coffee factories found in coffee estates empty their wastes into the river. The combination of agro-chemicals and wastes from coffee factories cause immense pollution of Mathare River upstream. The river then enters Karura forests before flowing through Muthaiga high class residential estate. After Thika road bridge, the river flows through Mathare Valley slums, low class Kariobangi estate and then Korogocho slums

before joining Nairobi river. As the river flows through Mathare Valley, it collects all sorts of garbage with it. There is some cultivation close to the river channel as the river passes through Mathare slums. After Outering Road bridge, there is a concrete crasher on one side of the river and grazing of goats from Kwa Michael on the other side.

Although land uses close to the rivers have pronounced impact on water quality in the rivers, it should be noted that other land uses away from the river valleys also have impact as long as they are within the same river basin. The nature of activities in the basin will be reflected in the water quality in rivers (Kwena, 1998). Therefore, its necessary to take care of all land uses in the river basin irrespective of their proximity to the river channels. As a result of these land uses along the rivers, water, sediment and biota of Nairobi rivers are heavily polluted by heavy metals, microbial and organic contaminants to the extend that they pose a great public health and toxicological risk to thousands of people who depend almost entirely on this river and its tributaries, for drinking, irrigation and aquatic life-forms (Ohayo, Mitoko, 1996).

4.3. Water Use in Relation to Other Natural Resources in Nairobi City

The respondents were presented with a list of seven resources found within Nairobi city and asked to identify those that they made use of in one way or another. Water resources had the highest frequency of use (73 or 76%). This can be associated with insufficient piped water supply and the same resource being expensive to the urban poor (Smith, 1996; Karagu, 1993). The poor have to seek for alternative sources of water, which is

found in the Nairobi's natural water bodies such as rivers. The water was used for various purposes such as watering flowers, bathing and washing cars. The next three resources in a descending order are vegetation (56 or 58.3%), soil (33 or 34.4%) and rocks (14 or 14.6%). Four respondents said they did not use any of the resources in the city. They cited inaccessibility as their reason for non-usage (Table 4.5).

Table 4.2:Natural Resource Use in Nairobi City

Resource	Frequency	Percent
Soil	33	34.4
Vegetation	56	58.3
Animals	8	8.3
Rocks	14	14.6
Clay	1	1
Murram	9	9.4
Water	73	76.0
None	4	4.2

The differences in resource use observed are significant. This is confirmed by the chi-square test which was applied to verify the hypothesis:

HO_1: There is no significant difference in the use of natural resources in Nairobi by respondents

Table 4.3: Results of Chi-square Test for Responses of Respondents on the Use of Natural Resources in Nairobi City.

Computed Value	405
Degrees of freedom (df)	7
Critical value at:	
0.01level of confidence	18.48
0.05 level of confidence	14.07

The results of chi-square test in Table 4.3 show that the computed value is greater than the critical value at 0.01 and 0.05 levels of confidence. This implies that the null hypothesis that there is no significant difference in the use of natural resources by respondents is not correct. The differences observed are real and not due to chance. This reflects the usefulness of some resources to the people of Nairobi compared to others. For instance, water is more useful to the people of Nairobi because of the shortages in the supply of the resource (Smith, 1996).

The 92 respondents who use natural resources in the city were further asked whether the resources they use is easily available. Fifty two (56.5%) answered in affirmative while 38 (41.3%) answered in negative. Two respondents (2.2%) did not respond. Those who said that the resources were not available were asked to give reasons for their scarcity. Twenty four (63.2%) cited pollution especially of water resources. This observation agrees with results of the studies such as Ohayo-Mitoka (1996), Wandiga (1996), Kithiia (1992) and Otieno (1998) found that rivers in Nairobi are polluted beyond use. Other reasons given were overuse by the high population in relation to the resources' natural regeneration and limitation of the resources in question to certain areas or seasons.

The 92 respondents who made of the resources in the city were latter asked what they thought should be done to alleviate the problems of scarcity of natural resources. They gave various suggestions ranging from guarding against pollution by enforcing environmental legislative structure which is weakly enforced (NCC, 1997; Kenya, 1991; Okoth-Ogendo, 1991) to practical planting of trees and clean-up campaigns (Table 4.4).

Table 4.4: Suggestions to Solve Problems Responsible for Natural Resources' Scarcity in Nairobi City

Suggestion	Frequency	Percent
Guard against rapid population increase	4	10.3
Plant and protect more trees	9	23.1
Guard against pollution of resources	10	25.6
Government to introduce incentives and disincentives on resource use	6	15.4
People to collaborate in managing resources	7	17.9
Educate people on the need to conserve environment	5	12.8
No idea	5	12.8
No response	3	7.7

4.4. Environmental Degradation Awareness in Nairobi City

The 96 respondents were asked whether they were aware of environmental degradation in Nairobi. 90 respondents (93.7%) answered in the affirmative while 6(6.3%) in the negative. Awareness of environmental degradation is greater among the populace of Nairobi because of poor garbage collection and water pollution in the city. The six respondents who were not aware of environmental problems in Nairobi were asked to proceed to answer questions on utilization of Nairobi rivers.

The 90 respondents who answered in affirmative to the question of environmental degradation awareness were invited to indicate the aspect of degradation they were aware of. Seventy seven respondents (85.5%) indicated that they were aware of water/river pollution followed by uncollected solid waste/land pollution 72(80%) and air pollution 49(54.4%) (Table4.5). Water/river pollution and uncollected solid waste are known by

majority of respondents because they have become a menace in Nairobi in the recent past. Due to rapidly growing human population Nairobi City Council has been unable to deal with large volumes of solid waste generated (Situma, 1992; Otieno, 1992; Lamba, 1994). As a result, stinking heaps of garbage is a common sight.

Table 4.5: Aspect of Environmental Degradation Known by Respondents

Aspect	Frequency	Percent
Water/river pollution	77	85.5
Uncollected waste/land pollution	72	80.0
Air pollution	49	54.4
Destruction of vegetation	34	37.8
Soil erosion/sedimentation	45	50.0
Destruction of wildlife	9	10.0
Water hyacinth	8	8.9
Grass fire	11	12.2
Destruction of open spaces	22	2.4
Wetland destruction	3	3.3

Solid wastes cause water pollution in two ways. First, the solid wastes are washed by storm run-off into water bodies thereby causing physical pollution. Second, solid waste left lying on the ground produce leachates which pollute water bodies they come in contact with. This is more serious when leachates contain dissolved chemicals (e.g. heavy metals) which are known to be poisonous to man and animals (Otieno, 1992). Owing to pollutants received, natural water-ways in Nairobi have been turned into flowing sewage. Inability by the City Council to maintain its over-loaded sewage system causes a lot of havoc to water in the rivers through pollutants received via broken sewage pipes. This inability to deliver can be attributed to wrangling and name calling a common phenomenon in city hall and undecidedness on whether the body should be city council or city commission. The result

of this undecidedness has resulted to undue changes from a council to a commission to a council again. These changes go along with changes in portfolios of senior officers hence affecting their performance. Nairobi rivers become recipients of raw sewage, improperly treated from sewage treatment works and industrial waste water treatment ponds. In addition, chemicals from acid rain resulting from industrial air pollution further pollute the water bodies. Nairobi rivers have been deliberately sacrificed for urbanization (cf. Annen, 1988).

Although there are clear differences in the aspect of environmental degradation known by respondents, it is necessary to determine whether the differences are due to chance occurrence or not. For this matter, chi-square test was performed to verify the hypothesis that:

HO_2: There is no significant difference between various aspects of environmental degradation known by respondents

Table 4.6: Results of Chi-square Test for Responses of Respondents on Environmental Degradation Known in Nairobi

Computed value	433.9
Degrees of freedom	9
Critical value at:	
0.01 level of confidence	21.67
0.05 level of confidence	16.92

Differences exist in the aspects of environmental degradation known by respondents. This is proved by the use of chi-square test results which show clearly that the computed value (433.9) is much greater than the critical value at both 0.05 and 0.01 levels (Table 4.6). the null hypothesis that there is no significant difference between various aspects of

environmental degradation known by respondents is untenable. The differences observed are significant and not due to chance. Aspects of environmental degradation were known according to the intensity in which they occurred where respondents lived and/or worked hence, the aspects that are wide spread were known by almost all respondents.

When analyzed by sex, majority of men (58 or 86.6%) and women (19 or 82.6%) were aware of water/river pollution. This is also the case with uncollected solid waste/land pollution where 64(80.6%) men and 18 (78.3%) women indicated knowledge of the problem (Table 4.7). The results indicate that irrespective of sex, all people were aware of deteriorating environmental conditions in Nairobi.

Table 4.7: Aspect of Environmental Degradation Known by Sex

Aspect Known	Men		Women	
	Frequency	Percent	Frequency	Percent
Water/river pollution	58	86.6	19	82.6
Uncollected waste/land pollution	54	80.0	18	78.3
Air pollution	36	53.7	13	56.5
Destruction of vegetation	22	32.8	13	56.5
Soil erosion/sedimentation	33	49.3	12	52.2
Destruction of wildlife	6	9.0	3	13.4
Water hyacinth	7	10.4	1	4.3
Grass fire	10	14.9	2	8.7
Destruction of open spaces	17	25.4	5	21.7

Further analysis was done according to level of formal education. Respondents with post-secondary level of education reported a higher frequency of awareness of all environmental problems in Nairobi except water hyacinth. Majority of respondents in different levels of

education knew of water/river pollution and uncollected solid waste/land pollution (Table 4.8). However, all respondents (12 or 100%) with post-secondary education level were aware of water/river pollution.

Table 4.8: Aspect of Environmental Degradation Known by Level of Formal Education

Aspect Known	Primary		Secondary		Post-secondary	
	Freq.	%	Freq.	%	Freq.	%
Water/river pollution	21	87.5	41	82	12	100.0
Uncollected waste/land pollution	18	75.0	41	82	11	91.7
Air pollution	15	62.5	24	48	9	75.0
Vegetation destruction	10	41.7	19	38	6	50.0
Soil erosion/sedimentation	15	62.5	23	46	6	50.0
Wildlife destruction	1	4.2	5	10	3	25.0
Water hyacinth	2	8.3	5	10	1	8.3
Grass fire	5	20.8	4	8	3	25.0
Open spaces destruction/landscape	4	16.7	12	24	7	58.3

When analyzed by age of the respondents, its clear that at least all respondents between age bracket 18 and 50 were aware of all environmental problems in Nairobi. However, those in the age brackets below 18 years and over 50 years were not aware of some aspects of environmental degradation (Table 4.9). This can be explained by the fact that age bracket below 18 years is made up of respondents of school going age who may be locked up in school and therefore less mobile. On the other hand, age bracket over 50 years may be less mobile due to their advanced age. This state of less mobility makes them loose touch with some environmental degradation reality apart from those experienced within their area of residence.

Table 4.9: Aspect of Environmental Degradation Known by Age

Aspect Known	Below 18 years		Between 18-30 years		Between 30-50 years		Over 50 years	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Water/river pollution	5	83.3	55	87.3	12	75.0	4	80
Uncollected waste	5	83.3	54	85.7	10	62.5	3	60
Air pollution	4	66.7	36	57.1	8	50.0	1	20
Vegetation destruction	0	0	23	36.5	9	56.3	2	40
Soil erosion	3	50.0	32	50.8	8	50.0	3	60
Wildlife destruction	0	0	8	12.7	1	6.3	1	20
Water hyacinth	0	0	5	7.9	3	18.8	0	0
Grass fire	2	33.3	7	11.1	2	12.5	0	0
Open Space destruction	2	33.3	18	28.6	3	18.8	0	0

The ninety respondents were asked whether they thought that most people in Nairobi were aware of environmental degradation. 66(73.3%) respondents gave affirmative answer while 21 (23.3%) gave a negative answer. However, 3(3.4%) respondents had no idea. The plausible reason for this is that environmental problems in Nairobi are a legion and on upward trend (Situma, 1992) a factor that makes them easily noticeable. A follow up was made on the 21 respondents who stated that most people in Nairobi were not aware of environmental problems. They were asked to give reasons they thought were leading to lack of awareness. They cited lack of public education, ignorance of the people and inaccessibility to information media (Table 4.10).

Table 4.10: Respondents' Reasons for Lack of Awareness of Environmental Degradation amongst People

Reason	Frequency	Percent
Ignorance among people	8	38.1
Lack of public education and awareness creation	10	47.6
Environmental degradation has not reached critical level to be felt	4	19.0
Inaccessibility to information media	4	19.0
Propaganda by environmental conservation agents	3	14.3
Illiteracy among people	2	9.2
No response	3	14.3

4.5. Utilization of Nairobi Rivers

The 96 respondents were presented with nine possible uses of water of Nairobi rivers and asked to indicate the uses people put to waters from the rivers. 51 respondents (56.7%) said that people used the waters for irrigation. 46 (51.1%) said people used the waters for domestic washing while 45(50%) said people used for waste disposal. The other uses

identified in descending order were car washing (41 or 45.6%), bathing (40 or 44.4%), livestock watering (24 or 26.7%), construction (23 or 25.6%), drinking 18(20%) and recreation (8 or 8.9%) (Table 4.11). The other uses included on the list were social-cultural uses e.g. circumcision and baptism (3 or 3.3%), socking waste papers to gain weight (4 or 4.4%) and brewing chang'a (2 or 2.2%). However, 4 respondents said that people do not use the water at all.

Table 4.11: Uses of Waters of Nairobi River by People

Use	Frequency	Percent
Drinking	18	20
Watering livestock	24	26.7
Domestic washing	46	51.1
Irrigation	51	56.7
Car washing	41	45.6
Bathing	40	44.4
Recreation	8	8.9
Waste disposal	45	50
Construction	23	25.6
Socio-cultural (circumcision)	3	3.3
Brewing alcohol (chang'aa)	2	2.2
Socking waste papers	4	4.4
Not applicable	4	4.4

Despite the fact that people in Nairobi have used more water than is available and polluted the remainder (Smith, 1996), the poor majority still make use of the contaminated remainder in the rivers. They use these waters in complete disrespect of the diseases such as cholera, Typhoid, Paratyphoid, Bacterial Dysentery, Amoebic Dysentery and Giardiasis which may be caused by such contaminated waters. The uses of contaminated water comes about because the poor in Nairobi slums pay more for water than the rich in prestigious

suburbs (Kwena, 1998; Smith, 1996; Lamba, 1994). Apart from the exorbitant rates for water that put off many people in the slums, periodic and chronic water shortages also sent people to the streams.

Kenya's national water policy of clean water to all by the year 2000 and UN General Assembly's International Drinking Water Supply and Sanitation Decade (IDWSSD) between 1981-1990 declared in 1980 have had very little impact on clean water provision to the poor in Nairobi. This is in respect to its objective of making safe drinking water available to all the people (Waiyaki, 1996). The government has to focus more on provision of water to the slum dwellers if it wants to prevent the poor from conducting water borne diseases as was witnessed in early 1998 (Sunday standard 9th May, 1999).

Chi-square was applied on the hypothesis that:

HO5: *There is no significant difference in the uses of waters from Nairobi rivers by respondents,*

to determine if the differences that were observed between the various uses of Nairobi rivers were real or due to chance.

Table 4.12: Results of Chi-square Test for responses of Respondents on the Uses of Waters from Nairobi Rivers

Computed value	717.8
Degrees of freedom	11
Critical value at:	
0.01 level of confidence	24.72
0.05 level of confidence	19.68

The results above show that the computed value is greater than the critical value at both

0.01 and 0.05 levels of confidence. This implies that the null hypothesis that there is no significant difference in the uses of waters from Nairobi rivers by respondents is untenable. The differences observed are real and not due to chance. This illustrates that people use these waters for various purposes according to their perceived cleanliness or the immediate pressing need for the water.

The 96 respondents were then asked to indicate the purposes for which they (themselves) used waters of Nairobi Rivers. 54(60%) said that they did not use the water. 21(23.3%) said that they used the waters for domestic washing, 16(17.8%) for bathing and 12(13.3%) for irrigation. Other uses cited in descending order were car-washing (7 or 7.8%), waste disposal (6 or 6.7%) and drinking (5 or 5.6%) (Table 4.13).

Table 4.13: Uses of Waters from Nairobi Rivers by Respondents

Use	Frequency	Percent
Drinking	5	5.6
Watering livestock	3	3.3
Domestic washing	21	23.3
Irrigation	12	13.3
Car washing	7	7.8
Bathing	16	17.8
Recreation	1	1.1
Waste disposal	6	6.7
Construction	2	2.2
Not applicable	54	60

There is a very big difference in the responses given by respondents when the same question concerning the use of water from Nairobi rivers was asked (Compare Tables 4.11 and 4.13). When asked what people used water of Nairobi rivers for, only 4 respondents (4.4%) indicated non-usage of the waters while when asked what the respondents themselves used

Plate 2 Use of Ngong River for Domestic Washing (Near Nairobi Dam).

Plate 3: Use of Mathare River for Car Washing

Nairobi rivers for, 54 or 60% indicated non-usage. This can be explained by the fact that although some respondents used the waters, they were shy to openly admit that they used the waters for fear of being thought poor or weak. This can be derived from the statement one respondent made that:-

> *"You are asking us questions and taking us photographs so that you can write and show us on papers (Daily News Papers) that we are poor we cannot afford tap water. You are like you have tap water at your homes."*

The researcher and his assistants witnessed a stream of people bathing and washing cloths in Ngong' River next to Nairobi Dam (Plates1& 3). Although only 12 respondents (13.3%) said they used waters from Nairobi rivers for irrigation, the practice of irrigating crops using the water is very common. This happens during dry season along the three rivers. Of late, there has been stern warning against using waters of Nairobi rivers which is often considered as sewage, for irrigation. Consumers of resultant vegetables have been cautioned against their consumption although it is difficult to differentiate between those grown along the rivers and those from up-country. Whereas to some people waters of Nairobi rivers look too polluted to be used, others use the same water for drinking, domestic washing, bathing and watering livestock.

The bathing points, for example, are found at least on each of the three rivers. On Ngong' River, the bathing point is in Nairobi Dam, on Nairobi River, it is at Museum bridge while on Mathare it is at Thika road bridge next to Utalii hotel. These uses of water of Nairobi rivers are likely to intensify as population outstrips 'imported' water supply from Sasumma Dam, Chania River Dam, Kikuyu Springs Dam and Ruiru Reservoir (Kwena, 1998; Karuga,

1993). Alternative to this shortage will be to resort to water from natural water bodies like rivers. However, this either cannot happen or it will happen with a lot of health risks from water borne diseases since people use the same waters for waste disposal as earlier noted.

The 96 respondents were asked if there was any negative effects of Nairobi rivers. Seventy one (78.9%) cited health risk through water borne diseases and disease vectors such as mosquitoes and Nairobi fly, 62 (68.9%) cited flooding of rivers causing loss of human life and property while 54 (60%) cited stench/foul smell from the water. Negative effects of rivers resulting to health risk and flooding are fresh in people's mind because of the recent El-nino induced rainfall that occurred in the late 1997 and early 1998. During these rains, Nairobi rivers flooded causing loss of human life and property. The rivers also became breeding grounds for disease vectors such as mosquitoes and what came to be called Nairobi fly. Of particular interest during this time was the Nairobi fly which cause a large burn on the skin where it was crashed (Shisanya and Khayesi 1999). 4 respondents (4.4%) cited occupation of economic space by the rivers as negative effect of the same. They argued that as the rivers passed through the Central Business District (CBD) they should be made sub-surface so that business enterprises can occupy the surface.

4.6. Conservation of Nairobi Rivers

4.6.1. Stakeholders Supposed to Conserve Nairobi Rivers

The 90 respondents were first of all asked who they thought was supposed to conserve Nairobi rivers. 39 (43.3%) respondents stated that it was the collaboration of all

stakeholders, 35 (38.9%) pointed the finger to the government while 27(30%) said it was the duty of residents along the rivers (Table 4.14).

Table 4.14 Respondents' View on who is Supposed to Conserve Nairobi Rivers

Institution/Group	Frequency	Percent
Government	35	38.9
Non-governmental Organization (NGO)	5	5.6
Religious groups	2	2.2
Local authorities	26	28.9
Residents in the basin	27	30.0
Collaboration of all stakeholders	39	43.3
No idea	2	2.2

In the past, people have had tendency to wait for the government and other organizations to do everything for them. However, due to the failure of the government and the organizations concerned to deliver, this tendency is slowly changing and people are turning more to collaborating with these institutions to conserve their environment. However, they do this with bitterness since they argued that they pay tax and service charge to the government and local authorities to do the work.

4.6.2. The Effectiveness of Stakeholders Supposed to Conserve Nairobi Rivers.

The respondents were further asked to rate the effectiveness of the institution(s) they thought is/are supposed to conserve Nairobi rivers at three levels namely:- below average, average and above average. 75 respondents (83.3%) felt that the effectiveness is below

average, 6 (6.7%) said it was average, 5 (5.6%) said it was above average while 3 (3.3%) respondents had no idea while one respondent did not answer the question. These results are exemplified by the fact that Nairobi rivers are polluted beyond any imaginable limit (Ohayo-Mitoko, 1996; Wandiga, 1996; Kithiia, 1992) yet there are institutions and people to take care of these rivers.

The differences exhibited in the rating the effectiveness of the stakeholders supposed to conserve Nairobi rivers by respondents were tested for significance by use of chi-square. The chi-square was applied to test the null hypothesis that:

HO_4: *There is no significant difference in the rating of the effectiveness of stakeholders supposed to conserve Nairobi rivers by respondents*

Table 4.15: Chi-square Test Results for Responses of Respondents on the Effectiveness of the Stakeholders Supposed to Conserve Nairobi Rivers

Computed value	226.5
Degrees of freedom	4
Critical value at:	
0.01 level of confidence	13.28
0.05 level of confidence	9.49

The results of chi-square test in Table 4.18 show that computed value (226.5) is greater than the critical value at both 0.01 and 0.05 levels of confidence. This implies that the null hypothesis is incorrect and therefore the differences observed are real and not due to chance. This reflects the varying perceptions of respondents in the amount of success obtained by stakeholders in the conservation of the rivers.

4.6.3. Efforts by Riparian People to Conserve Nairobi Rivers

The 90 respondents were asked what they were doing to reduce environmental degradation of Nairobi rivers. While 48 respondents (53.3%) stated that they managed domestic solid wastes that found their way into the rivers, 26(28.9%) admitted that they did nothing (Table 4.16).

Table 4.16: Individual Efforts in the Conservation of Nairobi Rivers

Conservation Exercise	Frequency	Percent
Controlling soil erosion	12	13.3
Planting trees and grasses	15	16.7
Managing domestic wastes	48	53.3
Avoiding cultivating on steep slopes	5	5.6
Sensitizing people	23	25.6
Avoiding or putting off grass fires	6	6.7
Nothing	26	28.9

However, it is not clear whether the management of solid waste is limited to transferring them from the house to heap outside or goes beyond that. Solid wastes pollute the rivers by either being carried by storm run-off to the rivers to cause physical pollution or causing chemical pollution by leachetes which emerge from them (Otieno, 1992). In this way, properly managed solid wastes will go along way in improving the quality of water in the rivers. Failure by the city council and other stakeholders to safely dispose off these solid wastes explains a bigger percentage of the state of Nairobi rivers. Many people's response in

regard to environmental degradation of Nairobi rivers has been reduced to apathy. They

argue that one person's effort alone cannot make a difference. This explains why many of them are actually doing nothing to bail out Nairobi rivers.

The differences in the conservation activities carried out by respondents were tested for significance by the use of chi-square. The chi-square was performed on the hypothesis that:

HO5: There is no significant difference in the conservation activities respondents are involved in

Table 4.17: Chi-square Results of the Responses of Respondents in the Conservation activities they are involved in

Computed value	403.8
Degrees of freedom	6
Critical value at:	
0.01 level of significance	16.81
0.05 level of significance	12.59

The results of the test reveal that the computed value (4.03.8) is much greater than the critical value at both 0.01 and 0.05. The null hypothesis stated above is rejected and therefore the differences observed are real and not due to chance. People are involved in various conservation activities according to the environmental problems experienced in their areas and what they can afford to do.

4.6.4. Factors that Retard Conservation Efforts of Nairobi Rivers

The respondents were presented with eleven factors that probably retard conservation efforts of Nairobi rivers. They were then asked to look at each factor carefully and rank it once on a qualitative scale: very important, important, fairly important and least important.

Lack of political will had the highest frequency on the very important scale (55 or 61.1%). The other factors on this scale in descending order were corruption (53 or 58.9%). Lack of law enforcement (53 or 58.9%), lack of cooperation (50 or 55.6%), lack of awareness campaign (49 or 54.4%), high population (49 or 54.4%), lack of financial resources (47 or 52.2%). The rest of the factors had less than 50% on this scale (Table 4.18).

Table 4.18: Rating of Factors that Retard Conservation Efforts of Nairobi Rivers.

Factor	V. Important		Important		F. Important		L. Important	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Lack of political will	55	61.1	12	13.3	11	12.2	12	13.3
Lack 0f awareness campaign	49	54,4	19	21.1	7	7.8	15	16.7
Lack of conservation skills	40	44.4	17	18.8	19	21.1	14	15.6
Lack of law enforcement	53	58.9	16	17.8	11	12.2	10	11.1
Lack of financial resources	47	52.2	15	16.7	5	6.7	22	24.4
Lack of co-operation	50	55.6	21	23.3	11	12.2	8	8.9
Lack of public concern	37	41.1	16	17.8	7	7.8	30	33.3
Conflicting policies and strategies	12	13.3	21	23.3	29	32.2	28	31.1
High population in the area	49	54.4	7	7.8	13	14.4	21	23.3
Effort duplication by stakeholders	14	15.6	19	21.1	24	26.7	33	36.7
Corruption	53	58.9	13	14.4	3	3.3	21	23.3

The rating of political will by a large proportion of respondents can be explained by a shift of focus by the government and political leaders from environment to tackle socio-economic problems such as unemployment that are considered more serious. However, it is important that socio-economic problems be tackled simultaneously with environmental problems since the two are interwoven. Corruption is another factor rated high in retarding

conservation efforts. Kenya is ranked as the most corrupt country in the world after Pakistan and Nigeria (Shisanya and Khayesi, 1999) and this permeates into the institution concerned with conservation of environment. In fact, lack of enforcement of law also rated high by respondents is to a large extent a creation of corruption, although low undeterent fines provided by the legal structure is also to blame (NEAP, 1994; Kenya, 1991).

When analyzed according to sex, more or less the same pattern emerges. Corruption was rated first as very important factor by men (41 or 61.1%). This was followed in descending order by lack of political will (38 or 56.7%), lack of cooperation, lack of enforcement of law and lack of awareness campaign (36 or 53.7%), lack of financial resources (35 or 52.2%), high population (34 or 50.7%) and lack of conservation knowledge (30 or 44.8%) (Table 4.19). Lack of political will (17 or 73.9%) was rated first as very important factor by the highest number of women. This was followed in descending order by lack of enforcement of law and high population (16 or 69.6%), corruption and lack of financial resources (13 or 56.5%), then lack of awareness campaign and lack of cooperation (12 or 52.2%) (Table 4.19).

Table 4.19: Rating of Factors Retarding Conservation Efforts of Nairobi Rivers By Sex

Factor	Men								Women							
	V. Important		Important		F Important		L. Important		V. Important		Important		F. Important		L. importa	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Lack of political will	38	56.7	9	13.4	10	14.9	10	14.9	17	73.9	3	13.0	2	8.7	1	4.
Lack of awareness campaign	36	53.7	15	22.4	6	9.0	10	14.9	12	52.2	6	26.1	0	0	5	21
Lack of conservation knowledge	30	44.8	11	16.4	14	20.9	12	17.9	11	47.8	6	26.1	5	21.7	1	4.
Lack of financial resources	35	52.2	12	17.9	5	7.5	15	22.4	13	56.5	3	13.0	1	4.4	6	26
Lack of enforcement of law	36	53.7	12	17.9	10	14.9	9	13.4	16	69.6	5	21.7	1	4.4	1	4.
Lack of co-operation	37	55.2	11	16.4	11	23.4	8	11.9	12	52.2	10	43.5	1	4.4	0	0
Lack of public concern	26	38.8	13	19.4	5	7.5	23	34.3	10	43.5	3	13.0	2	8.7	8	33
Conflicting policies and strategies	7	10.5	12	17.9	23	34.3	27	37.3	3	13.0	10	43.5	7	30.4	3	13
High population in the area	34	50.7	7	10.5	10	14.9	16	23.9	16	69.6	0	0	2	8.7	5	21
Effort duplication by stakeholders	8	11.9	15	22.4	17	25.4	27	40.3	2	8.7	5	21.7	8	33.3	8	33
Corruption	41	61.1	8	11.9	2	3.0	16	23.9	13	56.5	4	17.4	1	4.4	5	21

The rating of factors was further done by the highest level of formal education. Lack of awareness campaign, financial resources, enforcement of law and cooperation were all rated as very important by the highest number of respondents with primary level of education (15 or 62.5%) (Table 4.20a). However, lack of political will was rated as very important by the highest number of respondents with secondary level of education (31 or 62%). This was followed by lack of cooperation and high population (29 or 58%) (Table 4.20b). The factor rated high with the largest number of respondents with post-secondary level of education was lack of public concern (9 or 7.5%). It was then followed by corruption, lack of political will, awareness campaign, conservation knowledge and enforcement of law (8 or 66.7%) (Table 4.20c).

Table 4.20a: Rating of Factors that Retard conservation Efforts of Nairobi Rivers by Respondents with Primary Education Level

Factor	V. Important		Important		F. Important		L. Important	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Lack of political will	13	54.2	5	20.8	2	8.3	4	16.7
Lack of awareness campaign	15	62.5	6	25.0	1	4.2	2	8.3
Lack of conservation Knowledge	11	45.8	5	20.8	6	25.0	2	8.3
Lack of financial resources	15	62.5	2	8.3	1	4.2	6	25.0
Lack of law enforcement	15	62.5	6	25.0	1	4.2	2	8.3
Lack of co-operation	15	62.5	5	20.8	0	0	4	16.7
Lack of public concern	9	37.5	2	8.3	3	12.5	10	41.7
Conflicting policies and strategies	4	16.7	7	29.2	5	20.8	8	33.3
High population	11	45.8	2	8.3	5	20.8	6	25.0
Effort duplication	5	20.8	2	8.3	11	45.8	6	25.0
Corruption	13	54.2	6	25.0	1	4.2	5	20.8

Table 4.20b: Rating of Factors that Retard conservation Efforts of Nairobi Rivers by Respondents with Secondary Education Level

Factor	V. Important		Important		F. Important		L. Important	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Lack of political will	31	62	6	12	6	12	7	14
Lack of awareness campaign	24	48	11	22	4	8	11	22
Lack of conservation Knowledge	21	42	8	16	11	22	10	20
Lack of financial resources	23	46	11	22	2	4	14	28
Lack of law enforcement	27	54	8	16	9	18	6	12
Lack of co-operation	29	58	10	20	8	16	3	6
Lack of public concern	20	40	10	20	5	10	15	30
Conflicting policies and strategies	6	3	12	24	17	34	18	36
High population rea	29	58	4	8	5	10	12	24
Effort duplication	5	10.0	15	30	10	20	20	40
Corruption	26	52.0	9	18	2	4	12	24

Table 4.20c: Rating of Factors that Retard conservation Efforts of Nairobi Rivers by Respondents with Post-secondary Education Level

Factor	V. Important		Important		F. Important		L. Important	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Lack of political will	8	66.7	0	0	4	33.3	0	0
Lack of awareness campaign	8	66.7	3	25	0	0	1	8.3
Lack of conservation Knowledge	8	66.7	3	25	1	8.3	0	0
Lack of financial resources	7	58.3	1	8.3	2	16	2	16.7
Lack of law enforcement	8	66.7	2	16.7	0	0	2	16.7
Lack of co-operation	6	50	4	33.3	2	16.7	0	0
Lack of public concern	9	75	1	8.3	0	0	2	16.7
Conflicting policies and strategies	3	25	3	25	4	33.3	2	16.7
High population	6	50	2	16.7	1	8.3	3	25
Effort duplication	1	8.3	2	16.7	4	33.3	5	41.7
corruption	8	66.7	0	0	0	0	4	33.3

Apart from frequencies and percentages used to show the rating of the factors that retard conservation of Nairobi rivers, factor analysis was used to detect and identify groups of interrelated variables. Factor analysis was employed to test the hypothesis that:

HO_6: *There is no discernible pattern in the rating of factors that retard conservation efforts of Nairobi rivers*

The first step in the analysis involved deriving total scores for each of the factors (variables) based on a weighting scale as follows: very important (10 points), important (7), fairly important (4) and least important (1). Total scores are shown in Table 4.21.

Table 4.21: Total Scores on the Rating of Factors that Retard Conservation Efforts of Nairobi Rivers

Factor	Very Important	Important	Fairly Important	Least Important
Lack of political will	550	84	44	12
Lack of awareness campaign	490	133	28	15
Lack of conservation knowledge	400	119	76	14
Lack of law enforcement	530	112	44	10
Lack of financial resources	470	105	20	22
Lack of co-operation	500	147	44	8
Lack of public concern	370	112	28	30
Conflicting policies and strategies	120	147	116	28
High population	490	49	52	21
Effort duplication	140	133	96	33
Corruption	530	91	12	21

These scores were entered in SPSS program that carried out factor analysis as explained in chapter three. Interpretation of the factors (variables) utilized the resultant factor loadings, eigen values, tracer percentage and factor scree plot. The results of the factor loadings after rotation are shown in Table 4.22.

Table 4.22: Factor Loadings

Variable	Factor 1	Factor 2
Corruption	.98023	.19715
High population in the area	.97981	.16349
Lack of political will	.97476	.21582
Lack of financial resources	.97128	.23464
Lack of law enforcement	.96448	.26358
Lack of public concern	.95836	.27371
Lack of awareness campaign	.95542	.28972
Lack of co-operation	.94318	.32990
Lack of conservation knowledge	.93461	.35156
Conflicting policies and strategies	.11435	.99262
Duplication of efforts	.45073	.89201
Eigen value	9.59957	1.36462
Tracer percentage	87.3%	12.4%

In labeling the factors, variables with high loadings were used to search for a suitable name for it. Variables with high loadings in factor one are related to legal and supportive environment. Thus factor one is named supportive and enabling environment. This factor has an eigen value of 9.59957 explaining 87.3% of the variance in the rating of factors that retard conservation efforts of Nairobi rivers.

Factor two has high loadings on two variables which are linked to policy clarity and institutional arrangements and is therefore labeled policy clarity and institutional arrangements. This factor has an eigen value of 1.36462 explaining 12.4% of the total variance in the rating of factors that retard conservation efforts of Nairobi rivers.

The results of this analysis reveal that there is a pattern of association in the rating of factors that retard conservation efforts of Nairobi rivers. Legal and other supportive factors stand out as important compared to policy and institutional arrangements. It is therefore important for legal and financial matters to go hand in hand with institutional co-ordination and arrangements. The null hypothesis earlier stated is therefore rejected since there is clear association in the rating of factors that retard conservation efforts of Nairobi rivers.

4.6.5. Institutional Programs for Conservation of Nairobi Rivers

Five institutions with a stake in the conservation of Nairobi rivers were selected for in-depth interview on their programmes and activities in the conservation of Nairobi rivers. The institutions selected were Permanent Presidential Commission on Soil Conservation and Afforestation (PPCSCA) Tana and Athi Rivers Development Authority (TARDA), Nairobi City Council (NCC), Water Apportionment Board (WAB) and District Environmental Office (DEO).

PPCSCA was formed to coordinate efforts by various organs to promote land resource and environmental conservation programs. It is also involved in water catchment management

to conserve water in rivers. TARDA was formed by the Act of Parliament to guide sustainable development in Tana and Athi River basins. Nairobi rivers are constituent rivers of Athi River basin and they are therefore supposed to be conserved as a way of ensuring sustainable development.

Water Apportionment Board on the other hand is charged with responsibility of guiding abstraction and utilization of water resources and controlling pollution of the same. NCC is allowed by Water Act to identify pollution problems and enact by laws to set standards and impose penalties on defaulters as a way of conserving the rivers within its jurisdiction. DEO is supposed to oversee environmental conservation activities in his area of jurisdiction. It is charged with responsibility of coordinating environmental conservation activities in conjunction with other stakeholders aimed at ensuring pollution free environment sustainable development.

It is on the understanding of the responsibilities of each of the above institutions that they were selected for in-depth interview to gauge the amount of effort they put in conservation of Nairobi rivers. All these institutions admitted that they had no conservation programmes or activities specifically aimed to abate pollution of Nairobi rivers. However, they argued that they had programmes and activities in place that indirectly help to conserve Nairobi rivers. This is with understanding that well conserved environment will be reflected in good water quality in rivers (Golubev, 1993).

Table 4.23: Institutions' Conservation Programs and Implementation Strategies

PROGRAMME	INSTITUTION	IMPLIMENTATION STRATEGIES
Environmental conservation and afforestation	- TARDA - PPCSCA - DEO	▪ Educating people in public barazas. ▪ Creating awareness ▪ Making field days and visits ▪ Organizing Tree Planting Days
Water quality control and monitoring	- WAB - NCC - PPCSCA	▪ Measuring water quality and warning polluting firms and institutions
Water shed management	TARDA	▪ Providing free tree seedlings ▪ Making field days and visits to monitor progress
Environmental Clean-up campaign	- NCC - DEO	▪ Provide plastic papers and dustbins to deposit garbage. ▪ Luring people into physical clean up activities

4.7 SWOT Analysis

SWOT analysis in Table 4.24 provides management options for strategic areas derived from critical analysis of strengths, weaknesses, opportunities and threats in the conservation of Nairobi rivers. Strategies and weaknesses are merged with opportunities and threats and the resultant interaction used to construct strategy options that can improve the general management of Nairobi rivers. Each strategy adopted make use of the already existing

strengths and opportunities to check on weaknesses and threats facing the conservation process.

Table 4.24: SWOT Analysis Matrix for Strategic Management of Nairobi Rivers

Internal factors / External factors	**Strengths (S)** S1 Sound legal structure S2 Competent technological know-how S3 Adequate water and environmental conservation organizations S4 Enough manpower S5 High public interest	**Weaknesses (W)** W1 Lack of central coordination W2 Effort duplication W3 Corruption W4 Conflicting policies and strategies W5 Lack of political will W6 Law enforcement failure W7 High number of human and economic activities W8 Lack of financial resources W9 Lack of awareness campaign
Opportunities (O) O1 Houses UNEP-world body concerned with environment O2 Many donors ready to fund O3 World is concerned about environmental deterioration O4 New Environmental management and coordination bill to come into force soon	**Strength + Opportunities (SO)** • Organizations to develop environmental conservation projects for funding (S2, S3, S4, O1, O2, O3) • Involve the public in the conservation activities (S1, S4, O4)	**Weaknesses + Opportunities (WO)** • Set up Environmental Protection Agency (EPA) in Nairobi (W1, W2, W3, W4, W6, W9, O1, O2, O3, O4) • Local leaders to mobilize the public in environmental conservation (W5, W6, W8, O2, O4)
Threats (T) T1 Aid withdrawal from Kenya T2 High political focus on socio-economic problems T3 Inability to perform EIA T4 High population increase T5 Desire to establish more industries T6 Government experiencing economic difficulties T7 High poverty level	**Strengths + Threats (ST)** • Combine economic and environmental development (S1, S2, S4, T2, T4, T5, T6, T7) • Carry out EIA for development projects (S2, S4, T3, T5) • Persuade donors to resume aid (S3, T1, T6)	**Weaknesses + Threats (WT)** • Strengthen environmental law enforcement (W5, W6, W7, T3, T4, T5) • Enhance poverty reduction campaigns (W3, W8, W9, T1, T2, T6, T7)

4.8 Summary

This chapter set out to ascertain land uses in Nairobi river valleys, uses of the waters of the rivers and conservation efforts of Nairobi rivers, taking Nairobi, Ngong and Mathare rivers as case study. The land uses along the rivers were basically found to be cultivation, residential, commercial and industrial. These land uses were found to affect negatively

water quality in the rivers. Residential and cultivation land uses were found to stretch along the entire courses of the rivers with intensification at certain areas.

When the 96 respondents were presented with natural resources in Nairobi and asked to identify those they used in one way or another, 73(76%) indicated that they use water resources, 56 (58.3%) use vegetation while 4(4.2%) said they did not use any of the resources. The 92 respondents who indicated usage of the resources were further asked whether the resources they use were readily available. Fifty two (56.5%) answered in the affirmative while 38(41.3%) in the negative.

When the 96 respondents were asked whether they were aware of environmental degradation in Nairobi, 90 (93.7%) answered in the affirmative and 6(6.3%) in the negative. The 90 respondents who stated they were aware of environmental degradation were asked to state the aspect of environmental degradation in Nairobi city they were aware of. Seventy seven (85.5%) and 72 (80%) respondents were aware of water/river pollution and uncollected solid waste/land pollution respectively. When the 90 respondents were asked whether they thought that most people were aware of environmental degradation, 66(73.3%) answered in affirmative while 21(23.3%) in the negative.

When the 96 respondents were presented with nine possible uses of waters of Nairobi rivers and asked to indicate the uses people put to the waters, 51(56.7%) stated that people used the waters for irrigation while 4 respondents (4.4%) said that people did not use the waters at all. When the 96 were asked what they (themselves) used the waters for, 54(60%) said

that they did not use the waters while 21(23.3%) said they used the waters for domestic washing. When the 96 respondents were asked if there was any negative effects of the Nairobi rivers, seventy one (78.9%) cited health risk while 62(68.9%) cited flooding of the rivers causing loss of life and property.

When 90 respondents were asked who they thought was supposed to conserve Nairobi rivers, 39(43.3%) respondents stated that it was collaboration of all stakeholders while 35 (38.9%) respondents said it was the duty of the government. The respondents were asked to rate the effectiveness of the institution(s) they thought is/are supposed to conserve Nairobi rivers. Seventy five (83.3%) respondents felt that the effectiveness was low. When the 90 respondents were asked what they were doing to reduce environmental degradation of the rivers, 48(55.3%) respondents stated that they managed domestic solid wastes, while 26(28.9%) admitted that they were doing nothing.

When the 90 respondents were presented with eleven factors that probably retard conservation efforts of Nairobi rivers and asked to rank each on a qualitative scale: very important, important, fairly important and least important, lack of political will had the highest frequency on the very important scale (55 or 61.1%). The other factors were corruption (53 or 58.9%), lack of law enforcement (53 or 58%), lack of cooperation (50 or 55%). When the five institutions concerned with environment were asked what programmes or activities they had for conservation of Nairobi rivers, they stated that they had no program specifically for conservation of Nairobi rivers. However, what they had was for their entire area of operation.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The main object of this study was to establish land uses along Nairobi, Ngong and Mathare rivers, uses of their waters and management of their valleys and waters. To achieve this object, the study was guided by the following research questions:

- What land use activities exist along the valleys of Nairobi, Ngong and Mathare rivers? How do these land use activities affect the quality of water in river channels?
- How do people along the river valleys use the rivers and their waters? What are the conceived effects of the rivers to the people along them?
- What conservation programs and efforts are employed to protect the river valleys and their waters? How effective is the implementation of these programs and efforts?

Research objectives addressed in this study were:

- To identify and describe land use activities along the river valleys of Nairobi, Ngong and Mathare.
- To assess the effects of land use activities along Nairobi, Ngong and Mathare rivers on quality of water in the river channels.
- To establish the uses of Nairobi, Ngong and Mathare rivers and their waters to the people along the river valleys.
- To examine the role of the people along the river valleys and other stakeholders in the implementation of the conservation programs and strategies.

The above objectives were achieved by use of both documentary and field-based surveys to collect and latter analyze data required. A questionnaire-based survey was used to collect data from 96 respondents on use, effects and management of Nairobi rivers. Documentary sources were used mainly to gather information on the effects of land use on the rivers, pollution status of the same as no quality measurement was carried out in this study.

5.1 Summary of Findings

This study set out to ascertain land uses in Nairobi river valleys, uses of waters from the rivers and their (rivers) conservation taking Nairobi, Ngong and Mathare rivers as case study. The land uses along the rivers were basically found to be cultivation, residential, commercial and industrial. These land uses were found to affect the water quality negatively. Residential and cultivation land uses were found to stretch along the entire courses of the rivers with intensification at certain areas.

When the 96 respondents were presented with natural resources in Nairobi and asked to identify those they used in one way or another, 73 (76%) indicated that they use water resources, 56 (58.3%) use vegetation while 4 (4.2%) said they did not use any of the resources. The 92 respondents who indicated usage of the resources were further asked whether the resources they use were readily available. Fifty two (56.5%) answered in the affirmative while 38(41.3%) in the negative.

When the 96 respondents were asked whether they were aware of environmental degradation in Nairobi, 90 (93.7%) answered in the affirmative and 6 (6.3%) in the negative. The 90 respondents who stated they were aware of environmental degradation were asked to state the aspect of environmental degradation they were aware of. Seventy seven (85.5%) and 72 (80%) respondents

were aware of water/river pollution and uncollected solid waste/land pollution respectively. When the 90 respondents were asked whether they thought that most people were aware of environmental degradation, 66 (73.3%) answered in affirmative while 21 (23.3%) in the negative.

When the 96 respondents were presented with nine possible uses of waters of Nairobi rivers and asked to indicate the uses people put to the waters, 51(56.7%) stated that people used the waters for irrigation while 4 respondents (4.4%) said that people did not use the waters at all. When they were asked what they (themselves) used the waters for, 54 (60%) said that they did not use the waters at all while 21 (23.3%) said they used the waters for domestic washing. When the 90 respondents were asked if there was any negative effects of the Nairobi rivers, seventy-one (78.9%) cited health risk while 62 (68.9%) cited flooding of the rivers causing loss of life and property. When 90 respondents were asked who they thought was supposed to conserve Nairobi rivers, 39 (43.3%) respondents stated that it was collaboration of all stakeholders while 35 (38.9%) respondents said it was the duty of the government. The respondents were further asked to rate the effectiveness of the institution(s) they thought is/are supposed to conserve Nairobi rivers. Seventy-five (83.3%) respondents felt that the effectiveness was low. When the 90 respondents were asked what they were doing to reduce environmental degradation of the rivers, 48 (55.3%) respondents stated that they managed domestic solid wastes, while 26 (28.9%) admitted that they were doing nothing.

When the 90 respondents were presented with eleven factors that probably retard conservation efforts of Nairobi rivers and asked to rank each on a qualitative scale: very important, important, fairly important and least important, lack of political will had the highest frequency on the very important scale (55 or 61.1%). The other factors were corruption (53 or 58.9%), lack of law

enforcement (53 or 58%), lack of cooperation (50 or 55%). When the five institutions concerned with environment were asked what programmes or activities they had for conservation of Nairobi rivers, they stated that they had no program specifically for conservation of Nairobi rivers. What they had was for their entire area of operation.

Statistical tests using chi-square technique revealed that the differences observed in the responses pertaining to natural resource use, aspects of environmental degradation known, uses of waters of Nairobi rivers, rating of the effectiveness of the groups supposed to conserve Nairobi rivers and conservation activities individuals are involved in are significant. Therefore, the differences are not due to chance but represent differences in population.

The results of factor analysis illustrate that there is a pattern of associations in the rating of factors that retard conservation efforts of Nairobi rivers. The first group of interrelated variables is that to do with supportive and enabling environment while the second are those related to policy clarity and institutional arrangements. These results led to the rejection of the null hypothesis that there is no discernible pattern in the rating of factors that retard conservation efforts of Nairobi rivers.

5.2 Recommendations

Based on the findings of this study, the following recommendations are made:

- ✓ Since land uses along the rivers are found to negatively affect water in the river channels, there is urgent need for the government and other stakeholders to harmonize land use activities and potential carrying capacities of the river valleys. This is in recognition of the fact

that these land use activities are indispensable to the poor urban majority.

- ✓ There is need for the Nairobi populace to understand that waters of Nairobi rivers are used for various purposes including drinking by the urban poor. Therefore it is imperative for the government and other non-governmental organizations to educate people to use the rivers sustainablly to allow others downstream to use the resource.

- ✓ Given that majority of respondents rated lack of enforcement of law as a very important factor retarding conservation of Nairobi rivers, there is need for renewed efforts and actions to be taken in enforcing environmental laws and city by-laws relating to waste disposal and water conservation to manage Nairobi rivers which are often considered as flowing sewages.

- ✓ The institutions that have a stake in the conservation of environment should focus their attention to conservation of Nairobi rivers since this is an area of great concern given that people use waters from these rivers for various purposes.

- ✓ There is need for a clear-cut policy that integrates all stakeholders in the management of Nairobi rivers and spells out institutional arrangements in the conservation process to avoid duplication of efforts.

BIBLIOGRAPHY

Abwao,P (1993) "The Determination of Water Quality Characteristics of Runoff from Consecutive Storms Within Nairobi's City Centre With a View to Planning for its Proper Management." M.Sc Thesis, University of Nairobi.

Adebayo, Y.R (1992) "A Case Study for Planning: Towards a Better city of Nairobi Climate", In ***African Urban Quarterly, Vol. 7 Nos. 1 & 2*** ed. By Obudho, R.A.

Aduwo, I.G. (1990) "The Role, Efficiency and Quality of Service of the Matatu Mode of Transport in Nairobi, Kenya." M.A Thesis, University of Nairobi.

Ambasht, R.S (1990): ***Environment and Pollution: An Ecological Approach***, Student and Friends & Co., Varanasi.

Annen, G (1988) " The Emscher River – A Model of Integrated Water Management in Urbanized Area: Problems and Challenges, Proceeding of the Conference On Hydrological Processes and water Management in Urban Areas" Held between April 24th – 29th, 1988, ed. By UNESCO.

Ahmed, S (1994) "The Rhetoric of Participation Re-examined: The State, NGOs and Water Users at Varanasi, Utter Pradesh, India". In the ***International Journal for all Environmental Professionals Vol.14 No.1, PP 3-16.***

Ariel, D (1995) "A Comprehensive Approach to Managing, Protecting and Rehabilitating Lakes and Reservoirs", In ***Restoring and Protecting the worlds Lakes and Reservoirs***, World Bank technical Paper No. 289, ed. By Ariel, D et al, Washington DC, 1995.

Biwas, A.K (1990) : "watershed Management" in ***Environmentally-sound Water Management***, ed. by Thanh, N.C and Biwas, A.K, Oxford Universty Press, Bombay.

Boseman, G and Phatak, A (1989) ***Strategic Management: Text and Cases***, John Wiley and Sons, New York.

Breen, P.F, Mag, V and Seymour, B.S (1994) " The Combination of a Flood Retarding Basin and a wetland to Manage the Impact of Urban Runoff", in ***Journal of Water, Science and Technology, Vol. 29 No. 4 PP 103-109.***

Dungan, P.J (1994): "Integrated Management of Wetlands: A Perspective from IUCN's Global Programme", Proceedings of a Seminar on Wetlands of Zimbabwe, ed. by Matiza, T and Crafter, S.A. PP 11-20.

Dowdeswell, E and Parish, F (1996) "Executive Summary". In ***Natural Resources Journal Vol. 36 No.2, PP iii-xii***

Douglas, M (1994) ***Sustainable Use of Agricultural Soils***, Development and Environment Reports, Berne.

Dyson, R.G (1990): ***Strategic Planning: Models and Analytical Techniques***, Jon Wiley and Sons. Chichester.

Ells, J.B. and House, M..A. (1994) "Integrated Design Approach for Urban Corridor Management" In ***Integrated River Basin Development***, ed. by Kirbye, C and White, WR, John Wiley and Sons, Chichester.

Frederiksen, H.D (1992) ***Water Resources Institutions: Some Principles and practices***, World Bank, Washington DC.

Golubev, G.N. (1993) "Sustainable Water Development: Implications for the Future". In ***International Journal of Water Resources, Development, Environment and Water Development, Vol.9 No.2***

Gitahi, S (1994) "Solid Waste management". From Proceedings of the Workshop on Abatement of Pollution in Nairobi Rivers Held on 17-18th October, 1994 at Gigiri, Nairobi

Gitonga, P.L (1992): "Agricultural Chemicals and wetlands" From Proceedings of a Seminar on Wetlands of Kenya, Nairobi, ed. by Crafter, S.A *et al. PP 161-164*

Hammond, R and McCullagh, P (1974) ***Quantitative Techniques in Geography: an Introduction***, Clarendon Press, Oxyford.

Howard, G.W. (1998) "Catchment Management and Nairobi Dam" from a workshop to assess the of interest in the problems of Nairobi Dam and surrounds, and investigate the options for Remedial Actions, held at Nairobi Sailing & SUB-AQUA Club on 30th April, 1998.

Johnston, R.J (1980): ***Multivariate statistical Analysis in Geography: a Primer on the General Linear model***, Longman, London.

Karembu, M.G. (1990) "Pesticide Use and Misuse by Smallscale Farmers in Kiambu" M.Ed Thesis Kenyatta University.

Karuga, J.G (ed.) (1993) actions towards a Better Nairobi: Report and Recommendations of the Nairobi City Convention, The Nairobi We Want, City Hall, July 27th – 29th, 1993.

Kenya, (1997) ***The Eighth National Development Plan 1997-2001,*** Government Printer, Nairobi.

_____(1991) A Report on Pollution Problems in the Rivers Passing Through Nairobi City, Office of the President (PPCSCA).

Kindler, J. (1984) "Coordinated Management of Land and Water Resources, Regionalization and

Institution" From Proceedings of the Seminar on River Basin Strategy Held in Li Koping, Sweden, ed. by Ulrik, L.

Kinyua, A.M. and Pacini, N (1991) "The Impact of Pollution on the Ecology of Nairobi-Athi River Systems in Kenya" ***In Journal of BioChemiPhysics, Vol.1 No.1***

Kipkore, K.w (1996) "Watershed Degradation and Soil and Water Coservation in Kenya" From Seminars on Integrated Water Resources Management in Kenya Proceedings, Nanyuki, January 22-25 ed. by Hirji *et al.*

Kithiia, S.M. (1992) "Effects of Industries and Other Land Use Systems on Water Quality Within the Nairobi River Sub-catchments, Kenya". M.Sc Thesis, University of Nairobi.

Koudstaal, R, Rijsberman, R.F and Savenije, H (1992) from Proceedings of International Conference on Water and Environment, Held between 26-31 January, 1992, Dublin, ed. By Obasi, G.O.P, PP 7-38.

Krhoda, G. O (1992) "The Hydrology and Flood Management strategies in the City of Nairobi, Kenya, In African Urban Quarterly Vol. 7 Nos. 1&2 ed. By Obudho, PP 38 – 49.

Krishnamurthy, W (1984) "The Relevance of River Basin Approach for Coordinated Land and River Conservation" From Proceedings of the Seminar on River Basin Strategy Held in Li Koping, Sweden, ed. by Ulrik, L.

Kwena, A.Z (1998) Collaborative Coservation of Nairobi River: Basin-Wide Approach, A Paper Presented at a Seminar at Bureau of Educational Research, Kenyatta University on 6th February, 1998.

Lamba, D (1994) ***Nairobi's Environment: A Review of Conditions and Issues***, Mazingira Institute, Nairobi.

Lee-Smith, D *et al* (1987) ***Urban Food Production and the Cooking Fuel Situation in Urban Kenya***, Results of 1985 National Survey, Mazingira Institute.

Lundqvist, J, Lohm, U and Falkenmark, M (1985): "River Basin Strategy for Co-ordinated Land and Water Conservation: Synthesis and Conclutions", in ***Strategies for River Basin Management***, ed. Lundqvist, J *et al*, D. Reidel Publishing company, PP 5-17

Ministry of Environment and Natural Resources, (1994) Kenya Forestry Masterplan: Development Programmes, Government Printer, Nairobi.

Moigne, G.L, Subramanian, A, Xie, M and Giltner, S (1994) ***A Guide to formulation of Water Resources Strategy***, World Bank, Washington D.C.

Muiruri, P.W. and Obudho, R.A. (1992) Spacial Organization and Use of Open Spaces for Recreation in Nairobi, Kenya. Paper Presented at the Elra 1992 Congress on Leisure and New Citizenship Universidaf Densto, Bilbao, Spain, June 9-14, 1992.

Mujwahuzi, M.R. (1995) "Water Allocation and Compensatory Measures Between Headwaters and Downstream Societies in a Basin Management Perspective". From Seminars on Integrated Water Resources Management in Kenya Proceedings, Nanyuki, January 22-25 ed. by Hirji *et al.*

Musgrave, D.C. (1978) "The Evolution of Integrated Water Management in United Kingdom". In The Thames/Potomac Seminars on An Exploration of Water Resources in U.S.A and U.K ed. by Blackburn, AM, Washington D.C.

Mwangi, M.A. (1989) The Role of Urban Agriculture in Food Security for the Urban Poor: A Study of Households in Nairobi, Unpublished Report.

Nairobi City Council, (1997) Updating Nairobi Masterplan for Sewer, Sanitation and Drainage: Sewage Treatment Works, Rivers and Industrial Waste Survey, Unpublished Manuscript

National Environmental Action Plan, (1994) ***National Environmental Action Plan Report,*** Government Printer, Nairobi.

Ndaruga, A.M (1998) "Impact of Water Quality Changes on Riverine Macrozoobenthic Diversity: A Case Study of River Gatharaini, Kiambu District, Kenya." M.Env Thesis, Kenyatta Univsersity.

Njuguna, G.s (1978): A Studyof Effects of pollution on a Tropical River in Kenya, M.Sc. Thesis, University of Nairobi.

Ntiba, M (1996): "Effects of Chemical, Organic and Microbial Pollutants on Nairobi Riverine Ecosystem and its Biodiversity" From workshop Report on Concentration of Heavy Metals, Orgaanochlorine Pesticides, Organic and Microbial Pollution in the Nairobi River and its Tributaries Held Between June 4-5, 1996, Nairobi.

Nyambok, I. O (1992) " Geological Factors Affecting Urban Growth and spatial Planning of the City of Nairobi, Kenya, In African Urban Quarterly Vol. 7 Nos. 1&2 ed. By Obudho, PP 1 – 5.

OECD (1989): ***Water Resources management: Integrated Policies***, OECD, Paris.

OECD (1991) ***Environmental Management in Developing countries***, OECD, Paris

Odipo, W (1987) The Effects of Industrial and Domestic Effluents on the Quality of Receiving Waters of Nairobi, Ngong and Ruiruaka Rivers, M.Sc Thesis, University of Nairobi.

Odira, P.M. (1991) "River Pollution Profile: A Case Study of Thika River". From Proceedings of the National Seminar on Technological Solutions for Economic Development in Kenya Now and

the 21st Century 14-15 March, 1991 at J.K.U.C.A.T ed. by Agoki, GS *et al.*

Odundo, P (1994) "Impact of Squatter on Pollution of Nairobi Rivers". From Proceedings of the Workshop on Abatement of Pollution in Nairobi Rivers Held on 17-18th October, 1994 at Gigiri, Nairobi.

Ogola, P.A (1998) "Surface Water Resources in Yata Division: Accessibility, Variations, Utilization and Conservation Aspects." M.Env Thesis, Kenyatta University.

Ohayo-Mitoko, G.J. (1996) "Concentration of Heavy Metals, Orgaanochlorine Pesticides, Organic and Microbial Pollution in the Nairobi River and its Tributaries". From workshop Report on Concentration of Heavy Metals, Orgaanochlorine Pesticides, Organic and Microbial Pollution in the Nairobi River and its Tributaries Held Between June 4-5, 1996, Nairobi.

Okoth-Ogendo, H (1991) "Managing Water Sheds in Kenya" in ***Gaining Ground***, ed by Kiriro,A and Juma, C, ACTS Press, Nairobi.

Ole Nkako (1992) "Wetland Conservation in Kenya: KWS and Ramsar" From Proceedings of a Seminar on Wetlands of Kenya, Nairobi, ed. by Crafter, SA *et al.*

Ongweno, F (1992) "Seasonal Wetlands in Nairobi". From Proceedings of a Seminar on Wetlands of Kenya, Nairobi, ed. by Crafter, SA *et al.*

Ongweny, G.S (1983): "Development of Water Resources," In ***Journal of Geographical Society of Kenya vol. 5 Nos. 1 and 2***, P 36-47.

Otieno, F. (1998) "Nairobi River, Can the Pollution Level be Reduced? In ***African Urban Quarterly, Vol. 10 nos. 1 and 2***, Nairobi.

_____ (1992) "Solid Wastes Management in the City of Nairobi: What are the Prospectsfor the Future?" In African Urban Quarterly Vol. 7 Nos. 1&2 ed. By Obudho

Rogers, P (1992): " Integrated Urban water Resource Management", from Proceedings of International Conference on Water and Environment, Held between 26-31 January, 1992, Dublin, ed. By Obasi, G.O.P, PP 7-38.

Saggerson, E.P. (1991) ***Geology of Nairobi Area***, MENR, Nairobi.

Sartor, J (1988): The interaction of Flood water flows in Sewer Networks and Small River Systems", from Proceedings of the Conference on Hydrological Processes and Water Management in Urban Areas, Held between 24-29 April, 1988, ed. By UNESCO, PP 113-120.

Shisanya, C.A and Khayesi, M (1999): A Survey on Awareness and Perception of Climate Change among Respondents in the City of Nairobi, Kenya, Research Report submitted to Organization for Social Science Research Eastern and Southern Africa (OSSREA), Addis Ababa.

Smith, D (1996) "Environmental Impact Assessment and Sustainable Supply of Water to the Poor Majority, From Seminars on Integrated Water Resources Management in Kenya Proceedings, Nanyuki, January 22-25 ed. by Hirji *et al.*

Sindiga, I (1988) "Early Medical Ideas and Spatial Evolution of Nairobi". Paper Presented at the First International Conference on Urban Growth and Spatial Planning of Nairobi, December, 1988.

Situma, F.D (1992) "The Environmental Problems in the City of Nairobi, Kenya" In African Urban Quartely Vol. 7 nos. 1 and 2, Nairobi, ed. By Obudho, R. A, PP 167 - 176.

Syagga, P and Kiamba, J. M (1992) "Housing the Urban Poor: A Case Study of Pumwani, Kibera and Dandora Estates in the City of Nairobi" In African Urban Quartely Vol. 7 nos. 1 and 2, Nairobi ed. By Obudho, R. A, PP 79 - 89.

Thenya, P.T. (1994) Problems of Pollution in Parts of Ruiru River Catchments, B.Sc Dissertation, University of Nairobi.

Thompson, A and Strickland, A (1993) ***Strategic Management: Concepts and Cases,*** Irwin Inc, New York.

United Nations, (1992) ***Earth Summit Agenda 21,*** Rio de Janeiro.

United Nations Environmental Programme, (1997) ***Wetlands and Integrated River Basin Management,*** UNEP, Gland.

United Nations Environmental Programme *et al*, (1989) Policy responses to Social Conflicts Over the Use of Water Among Competing Uses/users, Report on the Second Expert Workshop on River/lake Basin: Approaches to Environmentally sound Management of Water Resources, Bangkok.

Wandiga, S.O. (1996). "River Pollution in Developing Countries – A Case Study III: Effects of Industrial Discharges on Quality of Ngong River Waters in Kenya. From workshop Report on Concentration of Heavy Metals, Orgaanochlorine Pesticides, Organic and Microbial Pollution in the Nairobi River and its Tributaries Held Between June 4-5, 1996, Nairobi.

Waiyaki, P. G (1996) "Microbiological Contamination of Surface Water with Reference to the Nairobi River and its Implication to Health" From workshop Report on Concentration of Heavy Metals, Orgaanochlorine Pesticides, Organic and Microbial Pollution in the Nairobi River and its Tributaries Held Between June 4 - 5, 1996, Nairobi.

Waugh, D (1990) ***Geography: An Integrated Approach,*** Thomas Nelson and Sons Ltd, Edinburgh.

World Bank, (1993) ***Water Resources Management,*** World Bank, Washington D.C.

_____ (1996) ***African Water Resources: Challenges and Opportunities Sustainable Development***, World Bank, Washington D.C.

World Resources Institute, (1994); ***World Resources: A Guide to the Global Environment*** , Oxford University Press, New York.

I am Zachary Kwena Arochi, a postgraduate student in Kenyatta University, Department of Geography. I am currently conducting a research study entitled **"Access, Utilization and management of water resources of nairobi, Ngong and Mathare rivers of Nairobi catchment basin"** under the permit number OP/ 310092/41 from the Office of the President. I kindly ask you to cooperate in giving me the information I want. Thanks in advance for your cooperation.

Yours sincerely,

Zachary Arochi Kwena

Questionnaire

Questionnaire No. _____ Date _____

Location _____

A: **Socio-Economic Information**

Sex: 1. Male 2. Female

Age: 1. Below 18 years 2. Between 18 and 30 years

3. Between 31 and 50 years 4. Over 50 year

Highest Level of education attained 1. Primary_ 2. Secondary 3 Post-secondary

Occupational sector

1. Agriculture 2. Commerce 3. Industry 4. Jua Kali

5. Tourism 6. Transport 7. Education 8. Others (specify)

B: **Resource Use and Environmental Degradation**

1. For how long have you been in Nairobi?

1. Less than 1 year_ 2.Between 1 and 5 years 2. Between 6 and 10 years 4. Over 10 years ____

2. Below are natural resources in Nairobi Tick against those that you use in one way or another

1. Soil 2. Vegetation (trees, grass). 3. Animals 4. Rocks 5. Clay 6. Murram 7. Others (specify)

3 a) Are the resources you use in 2 above readily available?

YES NO

b) If not, tick on the correct reason (s).

1. Overuse 2. Non-renewable 3. Limited to certain areas or season

4. Restricted by the government 5. Pollution 6. Others (specify)

c) What do you think should be done to solve the problem(s) you have stated in b above?

4 a) Are you aware of a case(s) of environmental degradation in Nairobi city?

YES NO

b) If yes, choose from this list the aspect of environmental degradation you are aware of in Nairobi

city.

1. Water/river pollution 2. Land/soil pollution 3.Air pollution 4 Destruction of vegetation 5. Destruction of landscape 6. Siltation/sedimentation

7. Soil erosion 8. Destruction of wild animals 9. Destruction of green open spaces

10. Water hyacinth 11. Grass fire 12. Uncollected solid waste

13. Others (specify)

c) When did you first come to know about the problem of environmental degradation in Nairobi River basin?

1. 1960s 2. 1970s 3. 1980s 4. 1990s

d) From who or what sources in the table below did you come to know about the problem?

1. Friend 2. Newspapers 3. Radio 4. Television

5. Institutions 6. Observation 7. Others (specify)

e) Do you think that most people in Nairobi know about the problem of environmental degradation?

YES NO

f) If no, give reasons.

C: <u>Use of Nairobi rivers</u>

5a) What do people use the Nairobi rivers' water for?

1. Drinking 2. Watering livestock 3. Domestic washing 4. Irrigation

5. Car washing 6. Bathing 7. Recreation

8. Waste disposal 9. Construction 10. Others (specify)

b) What do you as an individual use Nairobi rivers' waters for?

1. Drinking 2. Watering livestock 3. Domestic washing 4. Irrigation

5. Car washing 6. Bathing 7. Recreation

8. Waste disposal 9. Construction 10. Others (specify)

c) What is the negative effects of Nairobi rivers do the people along them?

1. Flooding causing death and loss of property 2. Have strange smell

3. Health risk – cause waterborne diseases 4. Occupy space for economic activities 5. Others (specify).

D: <u>Conservation Efforts</u>

6a According to you, who is/are supposed to conserve or manage Nairobi Rivers?

1. Government 2. Non-governmental organization (NGO) 3. Religious groups

4. Local Authorities 5. Residents in Nairobi 6. Collaboration of all above groups

7. I don't know 8. Others (specify)

b) Is/are the group(s) you have ticked in 6a effectively doing their work as far as conservation of Nairobi Rivers?

YES NO

c) If no, what are your recommendations?

7 a) What are you doing as an individual about the problem of environmental degradation in Nairobi city? (Tick)

1. Control soil erosion 2. Plant trees and grasses 3. Manage wastes

4. Avoiding cultivating steep slopes 5. Sensitising people Avoiding or putting off grass fire. 7. Nothing 8. Others (specify).

b) Specify those with whom you have collaborated in carrying out the above activity(ies)?

1. Family members 2. Friends 3. Community 4. City council workers

5. Local administration 6. Religious groups 7. Alone 8. Others (specify)

8) Below is a list of factors that probably retard effective implementation of conservation efforts in

Nairobi River basin. Look at each carefully and rank it on each of the four levels, i.e 1 = Very important, 2 = Important, 3 = Fairly important and 4 = Least important.

	1	2	3	4
Lack of political will				
Lack of awareness campaign				
Lack of conservation knowledge				
Lack of financial resources				
Lack of enforcement of law				
Lack of Co-operation among stakeholders				
Lack of public concern				
Conflicting policies and strategies				
High population in the area				
Effort duplication by stakeholders				
Corruption				
Others (specify)				

E: Integration

9a) Have you been consulted or contacted by any organization, group of persons or person in the conservation of your environment?

YES NO

b) If yes, name your co-partners.

c) Do you think collaborative conservation of Nairobi Rivers is achievable?

YES NO

Give reasons for your answer.

d) If you were asked to be attending and contributing in meetings, seminars/workshops and clean-up gatherings aimed at conserving Nairobi Rivers, would you be willing to attend?

YES NO

10a) How would you rate the current level of cooperation between different institutions (organizations)/persons in the conservation of Nairobi Rivers?

1. High 2. Medium 3. Low 4. Absent 5. I don't know _

b) What are the reasons for your answer in question 12a?

c) How can the level of cooperation in the conservation of Nairobi Rivers be improved?

13a) Do you think that the conservation efforts of Nairobi Rivers are adequate?

YES NO

b) If no, what do you think is the problem?

c) How can the problem(s) stated above be solved?

11) What comment would you give to the institutions involved in he conservation of Nairobi River basin?